HISTORICAL OVERVIEW OF INDIAN MATHEMATICS

Mohammad Arif
Asst. Professor
Department of Mathematics, Statistics and Computer
Anjuman-I-Islam's
Akbar Peerbhoy College of Commerce & Economics
Mumbai, Maharashtra

Overview

Indian mathematics boasts a lineage spanning over 5,000 years, beginning in the ancient Indus Valley Civilization (c. 2500–1500 BCE) and flourishing through the Vedic, classical, and medieval periods. The Vedic texts (c. 1500–500 BCE) include early geometric and arithmetic ideas related to altar construction and ritual observance. In later periods—particularly the classical era (400–1600 CE)—Indian scholars like Aryabhata, Brahmagupta, Bhaskara I and II, and Madhava of Sangamagrama pioneered advances across arithmetic, geometry, algebra, trigonometry, and the emerging ideas that prepared the ground for calculus. Over centuries, these ideas were recorded in Sanskrit sutras and commentaries, which enabled both preservation and broad dissemination throughout South Asia, the Islamic world, and, eventually, Europe.

Decimal System and Concept of Zero

The most transformative Indian contribution is the decimal system with a true zero. The roots of this system appear in the Indus Valley and were developed fully by classical

scholars. Aryabhata formalized the concept of place value, while Brahmagupta (598–668 CE) established rules for zero's arithmetic and its function as both a placeholder and a number. Brahmagupta's definition of zero, or "shunya," and his laws of zero's operations (e.g., a number plus zero is itself, zero multiplied by anything is zero) are fundamental to modern mathematics. The Gwalior inscription attests to its use as early as the 7th century CE. This system, transmitted to the Islamic world and Europe, underpins all modern calculation and algebraic thought.

Advancements in Algebra

Indian mathematicians made major advances in algebra, including systematic procedures for solving linear and quadratic equations. Brahmagupta's "Brahmasphutasiddhanta" (628 CE) introduced general solutions for quadratic equations, including negative and irrational roots—centuries before Europe adopted such ideas. Indian algebraists also composed and solved indeterminate equations—especially the so-called "Pell's equation," solved by Bhaskara II (1114–1185 CE) through cyclic methods ("Chakravala"). These treatises also included rules for operations with negatives and zero.

Geometry and Trigonometry

Geometry in India found early expression in constructing intricate ritual altars. Classical mathematicians like Aryabhata and Brahmagupta offered innovative geometry, including formulae for areas of cyclic quadrilaterals ("Brahmagupta's formula") and circles, and developed trigonometric tables based on the sine function ("jya"). Aryabhata's use of the

half chord (precursor of modern sine) and the Kerala school's expansion on sine, cosine, and arctangent series laid the groundwork for trigonometry and inspired concepts central to modern analysis.

Calculus and Infinite Series

Although full calculus as formalized later in Europe was not developed, Indian mathematicians of the Kerala school (14th–16th centuries) discovered power series expansions for sine, cosine, and arctangent, and approaches to summing infinite series. Madhava of Sangamagrama derived the power series for π, laid the early seeds for the Taylor series, and presented procedures for calculating trigonometric values to high decimal places—all centuries before similar work in Europe.

Key Figures and Theorems

Aryabhata (476–550 CE): Systematized arithmetic/algebraic rules, tabled sines, approximated π, solved quadratic equations, introduced place value and zero.

Brahmagupta (598–668 CE): Articulated rules for zero and negative numbers, created the area formula for cyclic quadrilaterals, extended algebraic rules.

Bhaskara II (1114–1185 CE): "Lilavati" and "Bijaganita" advanced arithmetic, algebra, indeterminate equations ("Chakravala"), and rudimentary calculus.

Madhava of Sangamagrama (c. 1350–1425 CE): Infinite series for π, sine, cosine, insights leading towards calculus.

Nilakantha Somayaji (15th century): New astronomical models, refinements in trigonometry and series expansions.

Other prominent contributors include **Mahavira, Aryabhata II, and Kamalakara,** who extended work on polynomials, indeterminate equations, and geometry.

Methodology and Transmission

Mathematical results in India were stated as concise "sutras" or verses (slokas) for memorization, then expanded through prose commentaries. This method allowed for broad oral dissemination and later textual transmission. Indian mathematicians also developed algorithmic approaches and demonstrated certain results via proofs or "upapatti." These modes fostered systematic mathematical inquiry and allowed ideas to travel and influence developments in the Middle East, China, and Europe.

Influence and Legacy

The Indian decimal system and concept of zero reached the Islamic world via scholars like Al-Khwarizmi and later Europe, revolutionizing global mathematics. Algebraic procedures, geometric methods, and series expansions found echoes in later Western developments. The depth, creativity, and rigor of Indian mathematical theorems remain foundational to modern mathematics, as their ideas underpin computation, algebra, and calculus worldwide.

References

- Indian mathematics - Wikipedia

- MATH 1: Contributions of Indian Mathematicians

- Ancient India's Mathematical Impact - 3010tangents

- Significant Contribution of Ancient Bhartiya Mathematicians towards Vasudhaiva Kutumbakam

- Proofs in Indian Mathematics - M.D. Srinivas

- Famous Indian Mathematicians from Ancient to Modern India

- Mathematics in India - Bhāvanā

- Chronology of Indian Mathematicians - SlideShare

- Emergence of a New Era in the History of Indian Mathematics