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Aryabhata's Pioneer Contribution In Indian Knowledge System

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Abstract: The Indian Knowledge System (IKS) is a vast repository of knowledge developed over thousands of years, rooted in ancient texts like the Vedas, Upanishads, and Puranas. It covers philosophy, science, mathematics, and medicine with a holistic approach that integrates mind, body, and spirit. Aryabhata was a prominent Indian mathematician and astronomer who is the Father of Indian Mathematics. He is a well-known all around the world for his elegant pieces of work, legacy and inventions in these fields. He was the first mathematician and astronomer from the classical period of Indian mathematics and astronomy. His pieces of work include the Aryabhatiya (c. 499), the main surviving Scripture from Aryabhata's classical pieces of work which is scripted in 118 verses describing Hindu Mathematics up to that time. The place Kusumapura is situated near Pataliputra (Patna), the capital of the Gupta dynasty, where he wrote these two pieces of treatises. It studies subjects such as plane and spherical trigonometry, quadratic equations, arithmetic and algebra. Aryabhata's work also includes his notions of cosine, sine and inverse sine, which forms the foundation of trigonometry. He was also the first mathematician to obtain the calculation based on sine and versine tables from 0 to 180 degrees with four decimal places of precision. Today, IKS represents a dynamic blend of traditional wisdom and modern scientific advancements, contributing significantly to science, technology, medicine, mathematics, literature, and philosophy.

***Index Terms* - Component, formatting, style, styling, insert.**

I. INTRODUCTION

Aryabhata (476–550), also known as the father of Indian Mathematics was a renowned astronomer and mathematician of the ancient times of India. He was an Indian astronomer and mathematician who wrote several works on mathematics and astronomy, including Aryabhatiya and Arya-Siddhanta. "Aryabhatiya", Sanskrit book that summarizes astronomy and mathematics. It is still used in modern Indian mathematical research. The book is written in the form of a sutra, which is a collection of aphorisms. The mathematical part of the book covers arithmetic, algebra, trigonometry, fractions, and quadratic equations. The astronomy part of the book is known as Khagol-Shastra. This is Aryabhatta's most well-known work, written in Sanskrit and divided into four sections. It covers a wide range of topics, including Mathematics, Astronomy and Cosmology. "Arya-Siddhanta", this work deals with astronomical calculations and describes several astronomical instruments, including a gnomon, shadow instrument, angle-measuring devices, a cylindrical stick, and an umbrella-shaped device. This work is based on the older Surya Siddhanta. He discovered zero by using it in the decimal system. He made the concept of zero and used it in large numbers. Aryabhata made many more discoveries in mathematics such as trigonometric equations, the value of pi, equations on mathematical progression, and quadratic equations. His work was well-received in the Islamic world, particularly his astronomical findings. His work influenced the development of mathematics in India and early European mathematics (Satya & Shiva, 2015).

Aryabhata's contributions to mathematics is truly unmatched, and not only limited to theoretical advancements but also extended to solve and understand the practical applications in the various fields, namely navigation, architecture, and timekeeping. He is a distinguished ancient Indian mathematician, his original work laid the foundational principles in mathematics, astronomy and physics. His work touched various areas including astronomical calculation, trigonometry, number system and planetary position. He is credited for the development of the concept of zero, the use of algebraic calculation of the value of pi. He was also involved in the creation of mathematical system and foundation of trigonometry, he is the one who mention of sine and give the sine table to the world. In astronomy, he worked on time computation, spherical geometry with the study of planet positions (Efrén &Pérez ,2022) This is sample paper format only please use this format and follow this structure as per your requirement

II. ARYABHATA'S WORK ON ALGEBRA

In this section we study a brief introduction of Aryabhata's work on algebra. The honour of 'Father of Algebra' was also attributed to Aryabhata because of his notable understanding and explanation of planetary systems. These pieces of his work of Algebra were established out of studying the problem in astronomy for determining the periods of the planets. It describes integer solutions to equations of the form $by = ax + c$ and $by = ax - c$, where a, b, c are integers. Aryabhata makes use of the algorithm called "Kuttaka" to solve problems of this type. It is well known that the word Kuttaka means "to pulverise" and the method of breaking the problem down into new problems where the coefficients become smaller and smaller with each step. The method here is essentially making use of the Euclidean algorithm to find the greatest common divisor of a and b, and it is also related to continued fractions. In Aryabhatiya, Aryabhata provided elegant results for the summation of series of squares and cubes like those as follows:

$$1^2 + 2^2 + \cdots + n^2 = [n(n+1)(2n+1)]/6,$$
$$1^3 + 2^3 + \cdots + n^3 = [((n+1))/ 2]^2$$

Aryabhata gives formulae for the areas of a triangle and that of a circle which are found to be correct. He introduced a mathematical algorithm for the sum of an arithmetic progression Sn. He also formulated another one for the number of terms n given that the sum is clearly in the knowledge domain. His course of action for computing the sum of an arithmetic progression is based on the mathematical relationship between the initial term a and the common difference d of alternate terms.

The main Scripture is Aryabhata's classical pieces of work named "Aryabhatiya". It is a small astronomical book scripted in 118 verses in total. It describes a note of Hindu mathematics up to that time. Its mathematical section consists of 33 verses with 66 mathematical rules without proof. The Aryabhatiya consists of 10 verses for the introduction section, followed by a subsection on mathematical contents with, and as already mentioned, 33 verses. Thereafter, a section of 25 verses on the reckoning on time and planetary working models is composed. Its final chapter consists of 50 verses on the sphere and eclipses titling this section with 'Set of ten giti stanzas'. The mathematical section of the Aryabhatiya includes algebra, arithmetic, spherical trigonometry and plane trigonometry. It also includes continued fractions, quadratic equations, a table of sines and sums of power series (Clark, W.E 1930).

III. ARYABHATA'S PIECES OF WORK ON INDETERMINATE EQUATIONS

In this section we study contribution of Aryabhata in indeterminate equations. Indeterminate equations of the second or higher degree contain two or more unknowns to solve for. Diophantine system of equations is equations of polynomial expressions for which rational or integer solutions are much sought after. In system of indeterminate equations, the number of unknowns exceeds the number of equations. Furthermore, these unknowns are subject to further constraints such as being integers, or positive integers, or rationals, etc. It is well known that indeterminate equations are not solvable uniquely. In fact, in some cases, it might even have infinitely many solutions. A problem of much gaining to Indian mathematicians since antiquity has been to find integer solutions to Diophantine equations that have the standard format of $ax + by = c$. This issue was also investigated in classical Chinese mathematics, and its solution is often referred to as the Chinese Remainder Theorem (Walter Eugene Clark ,1930).

IV. ARYABHATA CONTRIBUTION IN MOTIONS OF THE SOLAR SYSTEM

In this section we study contribution of Aryabhata on Motions of the Solar System. Aryabhata affirmed for each day that the Earth rotates about its axis. The movement of the earth causes the movement of the star, contrary to the prevailing viewpoint, that it is the sky that got rotated. This work can be glanced in the first chapter of the Aryabhatiya, where he discusses the number of rotations of the Earth in a Yuga, and more explicitly in his gola section. He described a geocentric model of the Solar System, in which the Sun and the Moon are each brought by epicycles. They in turn revolve around the Earth. In this phenomenal work, which is also found out there in the Paitamaha siddhanta (c. 425 CE), the motions of the planets are stated to be each governed by two epicycles, larger sighra (i.e., fast) and a smaller manda (i.e., slow). The sequence of the planets in terms of distance from the earth is taken as: the Moon, the Mercury, the Venus, the Sun, the Mars, the Jupiter, the Saturn, and the asterisms. The settings and periods of the planets were computed with respect to uniformly moving points. In case of Mercury and Venus, they move around the Earth at the same mean speed as the Sun. In the event of the Mars, the Jupiter, and the Saturn, they rotate the Earth at specific speeds, representing each planet's motion by the zodiac (Singh & Bag, 2004).

V. Aryabhata's study on Place Value System and Zero (0)

This section deals with the contribution of Aryabhata in Place Value System and Zero (0). The introduction of zero (0) brought a lot of drastic changes not only in mathematics but also in the day-to-day life of the perimeter of their base as the relationship between a circle's radius and its circumference. The pyramids are architectural marvels and are considered one of the Seven Wonders of the World. The Physicist Larry Shaw initiated celebrating 14 March as Pi Day at San Francisco's Exploratorium science museum. March 14 or 3/14 is considered pi day because 3.14 are the first digits of pi. The symbol for Pi has been in usage for over 250 years. The symbol was given by William Jones, a Welsh mathematician, in 1706. The symbol was made popular by the mathematician Leonhard Euler. As the accurate value of pi can never be computed, one can never find the exact area or circumference of a circle. People celebrate pi include Pi Approximation Day on July 22. The value 22/7 in the form of day/month is an approximation of π, and June 28. The number π is a constant in mathematics that is defined to be the ratio of a circle's circumference and its diameter. It is approximately equal to 3.14159. The number π appears in many formulae across mathematics and physics. Its decimal representation is of non-terminating and non-repeating pattern. It is a transcendental number, implying that it cannot be a solution of an equation involving only finite sums, products, powers, and integers. The transcendence of π implies that it is impossible to solve the ancient challenge of squaring the circle with a straight edge and compass. Aryabhata worked on the approximation for pi (π). It may have been observed that π is irrational number (Vijay& Govardhan, 2022).

The approximation of π correct up to five significant figures was first given by Aryabhata for to calculate the circumference of a circle of diameter twenty thousand units in the following verse: caturadhikam satamastagunam dvasastistathasaharanam ayuta dvaya viskambhasyasanno vrttav parinahah.

In the second part of the Aryabhatiyam (gaṇitapada 10), he explains that for a circle whose diameter is 20000, the circumference will come out to be 62832. This approximation was seen noted in Al-Khwarizmi's book on algebra, after Aryabhatiya was translated into Arabic (c. 820 CE).

VI. Conclusion

1. Integrating Indian Knowledge Systems (IKS) into higher education is a revival of ancient wisdom and a strategy for innovation, sustainability, and interdisciplinary research.
2. Aryabhata made significant contributions to the development of mathematics and astronomy, laying the foundation for modern mathematical concepts by introducing crucial ideas such as zero, the decimal system, and place-value system, value of Pi, motion of planets in solar system.
3. Aryabhata's ability to challenge existing beliefs and propose new ideas in mathematics and astronomy has shaped the trajectory of research in different areas, influencing generations of mathematicians and astronomers.

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