

MATHGENE

Departmental e-Magazine

Department of Mathematics



CITY COLLEGE, KOLKATA

102/1, Raja Rammohan Sarani, Kolkata-700009

Affiliated to University of Calcutta.

Mathgene

e-Magazine of the Department of Mathematics
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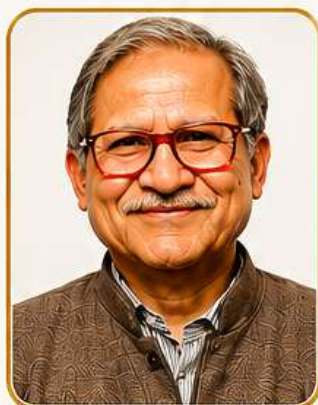
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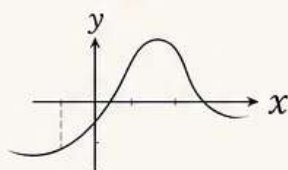
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জাহ্নবান লক্ষ্যতি জ্ঞাননম
ESTD. 1881



$$e^{i\pi} + 1 = 0$$

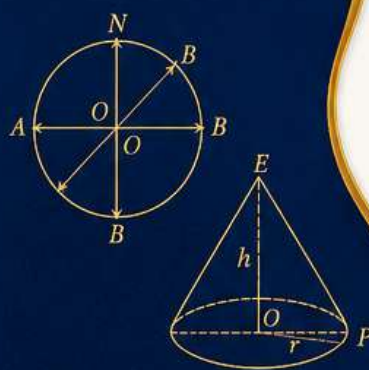


$$\int_a^b f(x) dx$$

$$\sum_{n=1}^{\infty} \frac{1}{n^2} = \frac{\pi^2}{6}$$

*"Mathematics
is not about numbers,
equations, computations
or algorithms:
it is about
understanding."*

— William Paul Thurston



MESSAGE OF GREETINGS

FROM THE

PRINCIPAL

ON THE RELEASE OF THE 1ST EDITION OF

MATHGENE

THE DEPARTMENTAL E-MAGAZINE OF THE
MATHEMATICS DEPARTMENT, CITY COLLEGE

I am delighted to extend my heartfelt greetings to the Mathematics Department of City College on the proud occasion of releasing the first edition of 'MATHGENE', their departmental e-magazine.

This initiative reflects the creativity, enthusiasm, and scholarly spirit of our students and faculty. Mathematics, often regarded as the language of the universe, not only develops logical thinking and analytical skills but also inspires innovation and problem-solving. Through 'MATHGENE', the Department has created a vibrant platform for sharing ideas, showcasing talent, and nurturing curiosity beyond the classroom.

I sincerely commend the Mathematics Department for fostering a culture of academic excellence, collaboration, and intellectual expression. I am confident that 'MATHGENE' will grow from strength to strength and become a meaningful platform that inspires and engages the entire college community.

My best wishes to the editorial team, contributors, and readers for a successful and enriching journey ahead. May 'MATHGENE' continue to enlighten minds, encourage creativity, and celebrate the beauty and power of mathematics.

Congratulations once again, and my very best wishes for the success of 'MATHGENE'!

A

Dr. Sital Prasad Chattopadhyay
PRINCIPAL
City College

MESSAGE

FROM THE VICE-PRINCIPAL'S DESK

TO

E-Magazine - 'MATHGENE', Department of Mathematics.



I am immensely pleased to know that the Department of Mathematics is bringing out its e-magazine *'MATHGENE'*.

Mathematics is the foundation of logical reasoning, scientific advancement and analytical thinking. In today's world, where innovation is driven by data and technology, cultivating a deep interest in mathematics is more important than ever.

'MATHGENE' is a laudable initiative that goes beyond textbooks and classrooms. It provides a vibrant platform for our students to explore, express and exchange mathematical ideas through articles, puzzles, concepts, applications and creative insights. This effort will undoubtedly help in removing the fear of mathematics and in nurturing curiosity and problem-solving skills among our learners.

I wholeheartedly congratulate the Honourable President, Principal of College and Head of the Department of Mathematics, the faculty members, the editorial board and all the student of our College, contributors for their dedicated efforts in bringing this e-magazine to life.

I wish 'MATHGENE' a grand success and hope it continues to inspire and enlighten many young minds in the years to come.

Dr. Mahitosh Gayen

Vice-Principal
City College, Kolkata-9

Message from the IQAC Coordinator



Dr. Sujita Datta Ghosh

It is a matter of immense pleasure and pride to extend my warmest greetings on the publication of the 1st Edition of the e-Magazine MATHZENE by the Department of Mathematics, City College.

From the perspective of the Internal Quality Assurance Cell (IQAC), such initiatives play an important role in promoting quality enhancement through active participation, collaborative learning, creativity, and knowledge sharing. An academic e-magazine can also contribute meaningfully to develop students' communication skills, critical thinking, research orientation, and confidence in expressing their ideas.

I sincerely appreciate the dedicated efforts of the editorial team, faculty members, and students whose enthusiasm and commitment have made this inaugural edition possible. Their collective endeavour is truly praiseworthy and reflects the spirit of academic collaboration that we seek to nurture at City College.

A few words from the Departmental Head

Dr. Masiur Rahaman Sardar



It gives me immense pleasure to convey my heartfelt greetings and best wishes on the publication of the 1st Edition of the e-Magazine 'MATHZENE' of the Department of Mathematics, City College.

One day, our senior-most faculty member, Prof. (Dr.) Rita Chanda, encouraged me to take the initiative to publish a departmental e-magazine. Since then, I have been working diligently to turn this vision into reality, and that dream was finally fulfilled in September 2026. In 2025, the department organised a value-added course on LaTeX. Under my guidance, the students of this course prepared several sample pages for the e-magazine, and those efforts eventually contributed to the making of this publication. I would like to express my sincere gratitude to these students for their valuable contribution.

The publication of MATHZENE marks a significant and memorable initiative of our department. Mathematics is not merely a subject of numbers, formulas, and abstract concepts; it is a beautiful language through which we understand patterns, logic, structure, and the world around us. This e-magazine provides a wonderful platform for our students and faculty members to express their mathematical creativity, curiosity, ideas, and reflections.

I sincerely appreciate the enthusiastic efforts of the faculty members and students who have contributed their valuable time, creativity, and intellect towards bringing this maiden edition to fruition. Such initiatives encourage academic engagement, nurture creativity, and strengthen the spirit of learning beyond the conventional classroom.

I hope MATHZENE will continue its journey with increasing enthusiasm and become a vibrant forum for mathematical ideas, innovative thoughts, literary expression, and scholarly interaction. May every subsequent edition inspire our students to explore the fascinating world of Mathematics with greater curiosity and confidence.

I extend my warm congratulations to everyone associated with the publication of the 1st Edition of MATHZENE and wish the e-magazine a bright, meaningful, and successful journey in the years ahead.

The Beauty and Mystery of Prime Numbers

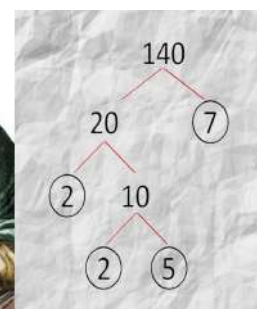
Samaresh Nath , Semester vi



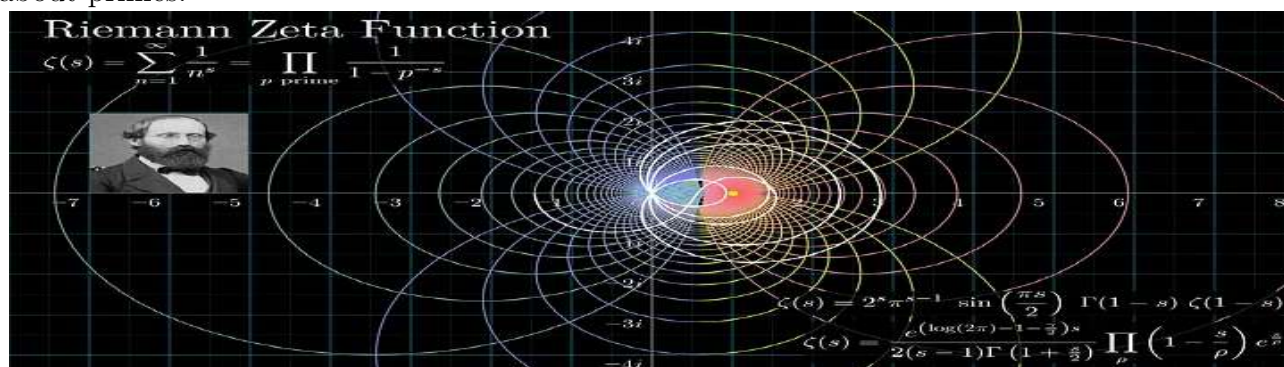
Mathematics is often regarded as the language of the universe, revealing hidden patterns in nature, technology, and reality. Among its many wonders, prime numbers stand out as one of the most intriguing and fundamental concepts. A prime number is a natural number greater than 1 that has only two divisors: 1 and itself. While this definition is simple, the properties and applications of prime numbers extend far beyond basic arithmetic.

100	99	98	97	96	95	94	93	92	91
65	64	63	62	61	60	59	58	57	90
66	37	36	35	34	33	32	31	56	89
67	38	17	16	15	14	13	30	55	88
68	39	18	5	4	3	12	29	54	87
69	40	19	6	1	2	11	28	53	86
70	41	20	7	8	9	10	27	52	85
71	42	21	22	23	24	25	26	51	84
72	43	44	45	46	47	48	49	50	83
73	74	75	76	77	78	79	80	81	82

The fascination with prime numbers dates back to ancient Greece, where mathematicians like **Euclid** explored their properties. Euclid provided one of the first known proofs that there are infinitely many prime numbers. This discovery was revolutionary, demonstrating that primes are not just a finite collection but an endless sequence that continues indefinitely. His proof remains one of the most elegant arguments in number theory.



One of the most famous problems related to prime numbers is the **Riemann Hypothesis**, proposed by Riemann in 1859. This unsolved problem concerns the distribution of prime numbers and their connection to the **Riemann zeta function**, a complex function that encodes information about primes.



The hypothesis states that all nontrivial zeros of this function lie on a critical line in the complex plane. Despite extensive numerical verification, a formal proof remains elusive, making it one of the seven **Millennium Prize Problems**, with a reward of one million dollars for a correct solution. Beyond theoretical curiosity, prime numbers have profound practical applications, particularly in **cryptography**. In modern digital security, prime numbers play a crucial role in encryption algorithms such as **RSA encryption**.

How RSA Encryption Works



This cryptographic system relies on the difficulty of factoring large composite numbers into their prime components. Since no efficient algorithm exists to factorize extremely large numbers, RSA encryption remains one of the most widely used methods for securing online transactions, email communications, and banking systems.

Another fascinating concept is the **twin prime conjecture**, which suggests that there are infinitely many pairs of prime numbers that differ by just 2, such as (3, 5), (11, 13), and (17, 19). Similarly, **Mersenne primes**, which take the form $2^p - 1$, have fascinated mathematicians for their rarity and connection to perfect numbers.

Prime numbers also influence patterns in **physics**, **quantum mechanics**, and even **music theory**. From ancient proofs to cutting-edge cybersecurity, prime numbers continue to shape the world around us. Their simple definition conceals an ocean of complexity, making them one of the most captivating subjects in mathematics. Whether used for exploring unsolved mysteries or securing digital communication, prime numbers remind us that mathematics is not just about numbers—it is about uncovering the profound truths that govern our universe.

Primes stand alone, so bold, so free,
 No friends to share their company.
 Divisible by just one and self,
 They guard their secrets, keep their stealth.
 No pattern clear, yet on they go,
 A mystery deep we long to know.

The Odyssey of Numbers: A Journey Through Number Theory from Ancient to Modern Times

*Dr. Nihar Sarkar,
Assistant Professor, Department of Mathematics,
City College, Kolkata-700009.*



Number theory is the study of numbers, especially whole numbers, and their relationships. It's one of the oldest and most important areas of mathematics, with a history stretching back thousands of years. Initially, it was used for practical purposes, like counting and measuring, but over time it became a field for deep thought and exploration. Number theory covers a wide range of topics, from cryptography to big unsolved problems like the Riemann Hypothesis. It began in ancient civilizations, moved through the intellectual changes of the Renaissance, and led to the development of modern mathematical methods. Today, it remains a vital area of research. The story of number theory is a mix of curiosity and practical use, from the early Greeks like the Pythagoreans to the exciting new discoveries being made today.

Part I: The Ancient Foundations

Early Beginnings

Number theory, like all mathematics, has its roots in the basic human need to count and measure. The earliest known use of numbers dates back to around 3000 BCE, in ancient Mesopotamia, where the Sumerians developed a base-60 (sexagesimal) numeral system for various applications, including trade, astronomy, and land measurement. This early system influenced many later mathematical conventions, including the division of the circle into 360 degrees.

In ancient Egypt, numbers were used to measure land, track harvests, and calculate taxes. The Egyptians were particularly interested in geometry and arithmetic, and their understanding of numbers was fundamental to constructing their monumental architecture, such as the pyramids.

However, the most significant early advancements in number theory occurred in **Ancient Greece**, with the Pythagoreans and later mathematicians who explored numbers not just as practical tools, but as objects of abstract thought.

The Pythagoreans and Early Concepts

The Pythagoreans, led by the philosopher and mathematician **Pythagoras** (c. 570–495 BCE), were the first to view numbers as more than just tools for measurement or counting. They believed that numbers were the very essence of reality, and they sought to explain the universe in terms of mathematical relationships. Their most famous result, the **Pythagorean Theorem** ($a^2 + b^2 = c^2$), laid the foundation for the study of integer solutions to equations, known today as **Pythagorean triples**.

For example, the integers 3, 4, and 5 form a Pythagorean triple, because $3^2 + 4^2 = 5^2$. This idea of finding integer solutions to simple geometric problems would remain central in number theory for centuries.

The Pythagoreans also made important contributions to the study of **perfect numbers**. A **perfect number** is a number that is equal to the sum of its proper divisors (excluding the number itself). The first perfect number is 6, because $1 + 2 + 3 = 6$. The study of perfect numbers would evolve over time, becoming a major area of number theory in later centuries.

The Greeks and Prime Numbers

The ancient Greeks, particularly **Euclid** (c. 300 BCE), made another groundbreaking contribution: the proof that there are infinitely many prime numbers. In his work *Elements*, Euclid proved that for any finite set of primes, there is always another prime not in the set. This result laid the groundwork for the study of prime numbers, which are integers greater than 1 that have no divisors other than 1 and themselves.

The ancient Greeks also explored the relationships between prime numbers and the divisibility of integers. The mathematician **Eratosthenes** (c. 276–194 BCE) devised the **Sieve of Eratosthenes**, an efficient algorithm for finding all prime numbers up to a given limit. This method remains one of the most fundamental algorithms in the history of number theory.

Greek Contributions to Divisibility

Greek mathematicians also investigated **divisibility**, an essential concept in number theory. The study of divisibility provided a foundation for later concepts such as **greatest common divisors** (GCD) and the development of the **Euclidean algorithm**, which allows the efficient calculation of the GCD of two numbers.

Part II: The Medieval Period and the Spread of Knowledge

The Islamic Golden Age

With the fall of the Roman Empire and the subsequent intellectual decline in Europe, much of the knowledge from ancient Greece and Rome was preserved and expanded upon by scholars in the **Islamic world** during the **Islamic Golden Age** (8th to 14th centuries). This era saw the flourishing of mathematics, including number theory, particularly in the works of scholars in the Middle East and Persia.

The Persian mathematician **Al-Khwarizmi** (c. 780–850) contributed significantly to the development of algebra, which would later influence the field of number theory. Though his work focused primarily on solving equations, his introduction of algorithms and systematic methods would become crucial to later number-theoretic research.

In the realm of number theory, **Al-Farabi** (c. 872–950) and **Al-Battani** (c. 858–929) continued the Greek tradition of studying prime numbers and divisibility. Additionally, the study of **perfect numbers** and other integer-related properties was continued by mathematicians such as **Ibn Sina** (Avicenna), who identified new examples of perfect numbers and explored their mathematical properties.

Indian Contributions to Zero and Negative Numbers

In **India**, mathematicians like **Brahmagupta** (598–668) and **Bhaskara** (1114–1185) made significant advancements in understanding **negative numbers**, **zero**, and **algorithms**. Brahmagupta's work on the rules for handling zero and negative numbers was particularly influential. His recognition that zero is a number in its own right, rather than merely a placeholder, set the stage for the later development of algebra and number theory.

Brahmagupta also worked on solving **Diophantine equations**—equations that seek integer solutions. These early investigations into Diophantine problems would evolve into some of the most significant areas of study in number theory.

Part III: The Renaissance – A New Dawn for Number Theory

The Rise of Algebra and Fermat

The **Renaissance** (14th to 17th centuries) was a period of intellectual reawakening in Europe, marked by the rediscovery of ancient Greek and Arabic mathematical works. This period saw number theory emerge as a distinct branch of mathematics, separate from other areas of study.

One of the most influential figures in this period was the French lawyer and mathematician **Pierre de Fermat** (1601–1665), who is often considered the father of modern number theory. Fermat is best known for his **Last Theorem**, which posited that there are no integer solutions to the equation $x^n + y^n = z^n$ for $n > 2$. This conjecture, famously written in the margin of his copy of an ancient text, remained unsolved for over 350 years, becoming one of the most famous problems in mathematics.

Fermat's contributions to number theory were vast. He made groundbreaking advances in **modular arithmetic**, particularly his famous **Fermat's Little Theorem**, which states that if p is a prime number, then for any integer a , $a^p \equiv a \pmod{p}$. This result laid the groundwork for the study of prime numbers and modular arithmetic.

Fermat's contemporaries, like **Blaise Pascal**, also contributed to the development of number theory. Pascal's work on **combinatorics** and the **Pascal's Triangle** introduced important insights into binomial coefficients, which would later play a critical role in modular arithmetic and algebra.

Part IV: The Age of Gauss – The Birth of Modern Number Theory

Carl Friedrich Gauss and the Systematic Study of Integers

The 18th and 19th centuries saw the rise of **Carl Friedrich Gauss** (1777–1855), a German mathematician who is often referred to as the "Prince of Mathematicians." Gauss's work in number theory laid the foundation for many of the concepts we now take for granted.

His monumental work *Disquisitiones Arithmeticae* (1801) introduced systematic methods for studying integers, including the use of **congruences** and **modular arithmetic**. Gauss's **Law of Quadratic Reciprocity** is a central result in number theory, dealing with the solvability of quadratic equations modulo prime numbers. This theorem was a major breakthrough in understanding the distribution of primes.

The Riemann Hypothesis and the Zeta Function

Another towering figure of the 19th century was **Bernhard Riemann** (1826–1866), whose work on the **Riemann zeta function** revolutionized number theory. The **Riemann Hypothesis**, proposed by Riemann in 1859, is one of the most famous unsolved problems in mathematics. It suggests that all nontrivial zeros of the zeta function lie on a critical line in the complex plane. This conjecture has profound implications for the distribution of prime numbers.

Riemann's work set the stage for later developments in analytic number theory, influencing generations of mathematicians who continue to study the properties of prime numbers and their connection to the zeta function.

Part V: The 20th and 21st Centuries – The Rise of Cryptography and Computational Methods

The Advent of Cryptography and the RSA Algorithm

In the 20th century, number theory found practical applications in the emerging field of **cryptography**. With the advent of computers and the need for secure communication, number theory became foundational in **public-key cryptography**.

The **RSA algorithm**, developed by **Ron Rivest**, **Adi Shamir**, and **Leonard Adleman** in 1977, relies on the difficulty of factoring large composite numbers into their prime factors. This application of number theory to encryption has transformed the way we secure information on the internet and is a testament to the continuing relevance of number theory in modern life.

Modern Computational Methods and Unsolved Problems

The 20th and 21st centuries also saw the development of powerful **computational methods** that have allowed mathematicians to solve previously intractable problems. Advanced algorithms and powerful computers have enabled the discovery of large prime numbers, as well as the verification of results like **Fermat's Last Theorem** (proved by **Andrew Wiles** in 1994).

Despite these advances, many important conjectures remain unsolved, including the **Riemann Hypothesis**, the **Goldbach Conjecture**, and the **Twin Prime Conjecture**. These problems continue to drive research and exploration in number theory.

Conclusion: The Enduring Legacy of Number Theory

From the ancient Egyptians and Babylonians to the cutting-edge work of modern-day mathematicians, number theory has evolved over millennia, growing from a practical necessity into one of the most abstract and intellectually challenging fields of mathematics. Today, number theory remains at the heart of mathematical inquiry, with applications ranging from cryptography to quantum computing. As the search for new prime numbers, the understanding of Diophantine equations, and the pursuit of unsolved conjectures continue, the journey of number theory shows no signs of slowing down. The field's rich history and ongoing mysteries ensure that number theory will remain one of the most vibrant and dynamic areas of mathematical exploration for generations to come.

জানা গণিতের অজানা রূপ :

(শূন্য থেকে অস্তিত্ব, অস্তিত্ব থেকে অসীম)

নাম - জয়শ্রী হালদার

ডিপার্টমেন্ট - ম্যাথমেটিক্স (মেজর)

সেমিস্টার- ১, রোল নং -২৬০৫০৪



ভূমিকা (Introduction):

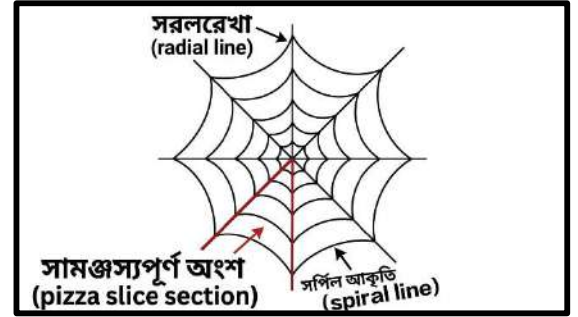
প্রাচীনকাল থেকে অদূর ভবিষ্যতের উন্নয়নের ক্ষেত্রে মানব জীবনে গণিতের গুরুত্ব অপরিসীম। গণিত শুধুমাত্র একটি বিষয় নয় এটি ‘বাস্তব’ এর রূপরেখার ওপর ভিত্তি করে তৈরি। বাস্তবের দৈনন্দিন জীবনের পরিস্থিতি গুলোকে সহজ করার উদ্দেশ্যে গণিতের জন্ম হয়।

‘গণিত’ বিষয়টি ঠিক একটা ‘চিত্রের’ মত, কেউ তার সৌন্দর্যতার প্রশংসা করে আবার কেউ মনে করে কেবল সংখ্যা আর ইংরেজি বর্ণমালার কঠিন বিন্যাস মাত্র। সবই নির্ভর করে নিজস্ব দৃষ্টিভঙ্গির ওপর। এই বিষয়টির জ্ঞান এবং সৌন্দর্যকে প্রকৃতভাবে উপভোগ করতে হলে প্রয়োজন, বিষয়টির প্রতি কৌতূহল, ধৈর্য, যুক্তি এবং কল্পনা করতে পারার ক্ষমতা।

চলুন তার একটি প্রাকৃতিক উদাহরণ ব্যবহার করা যাক। আপনারা প্রত্যেকেই কম-বেশি মাকড়সার জালের সাথে পরিচিত। কখনো কি এই জালটিকে গভীরভাবে পর্যবেক্ষণ করেছেন? করলে বুঝতে পারবেন এই সামান্য জালটির মধ্যে কি অসাধারণ গণিত লুকিয়ে রয়েছে। জাল তৈরির সময় মাকড়সা প্রথমে একটি শক্ত কাঠামো (Frame) তৈরি করে। এরপর সে কেন্দ্র থেকে চারদিকে সোজা সোজা সুতো টেনে সরলরেখা

(Radial Line) তৈরি করে। এই রেখাগুলো অনেকটা সাইকেলের চাকার স্পোকের ন্যায় কেন্দ্র থেকে চারদিকে ছড়িয়ে পড়োলক্ষ্য করলে দেখা যায়, পরপর দুটি রেখার (Radial Line) মধ্যে প্রায় সমান ব্যবধান বা কোণ বজায় থাকে। এর ফলে পুরো জালটি একটি ভারসাম্যপূর্ণ ও সুশৃঙ্খল রূপ লাভ করে। এরপর মাকড়সা কেন্দ্রকে ঘিরে ধীরে ধীরে সর্পিল (Spiral) আকৃতির সুতো বুনতে শুরু করে। এখন মজার ব্যাপার হলো এই সর্পিল রেখাগুলো কেন্দ্র থেকে সমদূরত্ব বজায় রেখে বিস্তৃত হয়। ফলে জালের প্রতিটি অংশ পরস্পরের সঙ্গে যুক্ত থাকে এবং একটি পুনরাবৃত্ত নকশা (Pattern) সৃষ্টি হয় এবং সবচেয়ে আকর্ষণীয় বৈশিষ্ট্য হলো এর সামঞ্জস্য (Symmetry)। কেন্দ্র থেকে বের হওয়া দুটি রেখার (Radial Line)

মধ্যবর্তী অংশগুলো অনেকটা পিৎজার স্লাইসের মতো। প্রতিটি অংশ প্রায় একই আকৃতির হওয়ায় জালের মধ্যে একটি সুন্দর ও সুশৃঙ্খল বিন্যাস তৈরি হয়। এর ফলে জালের এক অংশে যে নকশা দেখা যায়, অন্য অংশেও তার পুনরাবৃত্তি লক্ষ্য করা যায়।



'শূন্য' থেকে 'শূন্য' পর্যন্ত (Zero to Universe):

- শূন্য কী?

সাধারণভাবে শূন্য (০) বলতে বোঝায় "কিছুই না" বা কোনো পরিমাণের অনুপস্থিতি। কিন্তু আশ্চর্যের বিষয় হলো, এই "কিছুই না"-ই আধুনিক গণিতের অন্যতম গুরুত্বপূর্ণ ভিত্তি। শূন্য ছাড়া আজকের সংখ্যা পদ্ধতি, বিজ্ঞান, প্রযুক্তি এমনকি কম্পিউটারও কল্পনা করা কঠিন।

■ শূন্যের ইতিহাস

শূন্যের ইতিহাসও বেশ চমকপ্রদ। প্রাচীন ভারতীয় গণিতে শূন্যের ধারণার বিকাশ ধীরে ধীরে ঘটেছিল। ৪৯৯ খ্রিস্টাব্দে রচিত আর্যভট্টীয় গ্রন্থে মহান ভারতীয় জ্যোতির্বিদ ও গণিতবিদ আর্যভট্ট স্থানিক মান (Place value) পদ্ধতির ব্যবহার করেন, যা পরবর্তীকালে শূন্যের ধারণা বিকাশে গুরুত্বপূর্ণ ভূমিকা রাখে। তবে সে সময় শূন্যকে এখনও একটি স্বাধীন সংখ্যা হিসেবে গণ্য করা হতো না।

পরবর্তীতে ৬২৮ খ্রিস্টাব্দে ভারতীয় গণিতবিদ ব্রহ্মগুপ্ত তাঁর বিখ্যাত ব্রহ্মস্ফুটসিদ্ধান্ত গ্রন্থে শূন্য সম্পর্কিত গাণিতিক নিয়মাবলি সুস্পষ্টভাবে বর্ণনা করেন। তিনিই প্রথম শূন্যকে সংখ্যা পদ্ধতির একটি গুরুত্বপূর্ণ অংশ হিসেবে প্রতিষ্ঠিত করেন। তাঁর কাজের মাধ্যমে শূন্য গণিতের জগতে একটি সুসংহত রূপ লাভ করে।

তবে প্রশ্ন হলো, শূন্যের প্রচলনের আগে মানুষ কীভাবে গণনা করত? বিভিন্ন প্রাচীন সভ্যতা শূন্যের পরিবর্তে

বিভিন্ন প্রতীক বা চিহ্ন ব্যবহার করত।

স্থানের

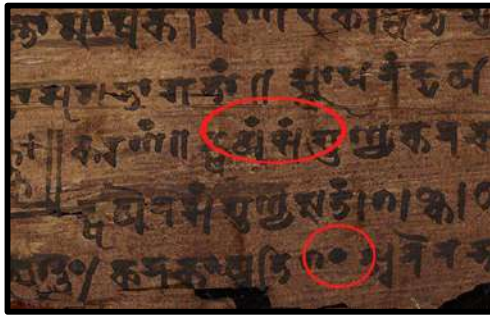
উদাহরণস্বরূপ, ব্যাবিলনীয় সভ্যতায় কোনো অনুপস্থিত মান বোঝাতে দুটি কোণাকুণি কীলক

চিহ্ন

(«) ব্যবহৃত হতো। মায়া সভ্যতায় ঝিনুকের

আকৃতির

ন্যায় একটি প্রতীক ব্যবহৃত হতো। প্রাচীন



মিশরীয়রা কিছু ক্ষেত্রে "নেফার" (𓂏) প্রতীক ব্যবহার করত, যদিও এটি আধুনিক শূন্যের সমতুল্য ছিল না।

অন্যদিকে চীনা গণিতবিদরাও খালি স্থান বা শূন্যস্থান বোঝাতে বিশেষ প্রতীক (○) ব্যবহার করতেন।

■ স্থানিকমান হিসেবে শূন্যের ব্যবহার

এখন একটি মজার প্রশ্ন ভাবা যাক। আমরা জানি, শূন্য মানে "কিছুই না"। তাহলে দশজন মানুষকে সংখ্যায় প্রকাশ করতে আমরা "১০" লিখি কেন? যদি শূন্যের কোনো মূল্যই না থাকে, তবে ১০ এর মান ১ হওয়া উচিত। কিন্তু বাস্তবে আমরা জানি, ১ মানে একজন মানুষ আর ১০ মানে দশজন মানুষ।

এই রহস্যের উত্তর লুকিয়ে আছে স্থানিক মান পদ্ধতিতে। এখানে শূন্য নিজে কোনো পরিমাণ নির্দেশ না করলেও সংখ্যার অবস্থান নির্ধারণে গুরুত্বপূর্ণ ভূমিকা পালন করে। ১-এর ডান পাশে একটি শূন্য বসলে সংখ্যাটি একক স্থান থেকে দশকের স্থানে চলে যায় এবং তার মান দশ গুণ বৃদ্ধি পায়। অর্থাৎ শূন্য শুধু "কিছুই নয়" নয়; বরং এটি এমন একটি শক্তিশালী ধারণা, যা সংখ্যা পদ্ধতিকে সুসংগঠিত ও কার্যকর করে তুলেছে।

তাই বলা যায়, শূন্যের প্রকৃত গুরুত্ব তার নিজস্ব মানে নয়, বরং অন্য সংখ্যার মান নির্ধারণে তার অসাধারণ অবদানে। "কিছুই নয়" থেকে শুরু করে আধুনিক গণিতের ভিত্তি হয়ে ওঠার এই যাত্রাই শূন্যকে মানব সভ্যতার অন্যতম শ্রেষ্ঠ আবিষ্কারে পরিণত করেছে।

■ শূন্যে জটিলতা

এবার এই 'কিছুই না' তে আরও কিছু যোগ করা যাক। আমরা প্রত্যেকেই জানি, একটি সংখ্যাকে অন্য কোনো একটি সংখ্যা দিয়ে গুণ করার পর যে উত্তর পাই, সেই উত্তরকে একই সংখ্যা দিয়ে ভাগ করলে আবার আগের সংখ্যাটিতেই ফিরে আসে। উদাহরণ স্বরূপঃ $4 \times 3 = 12$ হলে $12 \div 3 = 4$ অথবা $12 \div 4 = 3$ হবে।

কিন্তু শূন্যের ক্ষেত্রে এই প্রক্রিয়ায় জটিলতা দেখা যায়।

উদাহরণস্বরূপঃ $5 \times 0 = 0$

এবার এটাকে ভাগের নিয়ম (পাশের গণনা অনুযায়ী) দু-ভাবে লিখতে পারি—

① $5 \times 0 = 0 \Rightarrow 0 \div 5 = 0$ (অর্থাৎ: 0 সংখ্যাটিকে 5 পাঁচ ভাগে ভাগ করতে হবে যার অর্থ প্রত্যেক ভাগে 0 পাওয়া যায়)

② $5 \times 0 = 0 \Rightarrow 0 \div 0 = 5$

এটার অর্থ এটাই দাঁড়ায় যে 0 সংখ্যাটিকে 0 ভাগে ভাগ করলে সংখ্যার প্রত্যেক ভাগে 5 পাওয়া যায়।

এটা কী সম্ভব? না। দেখুন এই

এরপর একই ভাবে $10 \div 0 = 0$ যার অর্থ দাঁড়ায় $0 \div 10 = 0$ এবং $0 \div 0 = 10$

এখন একই $0/0$ এর মান এক জায়গায় 5 আবার আরেক জায়গায় 10 অর্থাৎ এর কোনো নির্দিষ্ট বা স্থির উত্তর দেওয়া সম্ভব নয়। আর তাই $0/0$ কে গণিতের ভাষায় অসংজ্ঞায়িত (Undefined) বলা হয়।

■ শূন্যের মধ্যেই অসীম

$0/0$ (Undefined)—কিন্তু এই যে শূন্য দিয়ে ভাগের ক্ষেত্রে আমরা থমকে গেলাম, এখানেই কি গল্প শেষ? একদমই নয়। এবার একটি সহজ পরীক্ষা করে দেখা যাক।

মনে করো, তোমার কাছে ১টি পিজ্জা বা একটি পুরো কেক আছে। এবার সেই কেকটিকে তুমি ভাগ করতে শুরু করলে:

কেকটিকে যদি 2টি বড় টুকরো করো, তবে প্রতিটি টুকরোর আকার হবে 0.5।

যদি 10 টি টুকরো করো, প্রতিটি টুকরোর আকার কমে হবে 0.1 ।

যদি 100 টি টুকরো করো, আকার আরও ছোট হয়ে হবে 0.01।

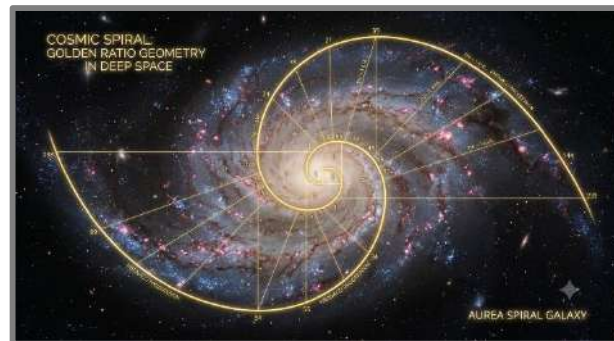
এবার হিসাবটাকে যদি আমরা উল্টোভাবে দেখি—আমরা যত ছোট বা সূক্ষ্ম মাপের টুকরো কাটব, কেকের মোট টুকরোর সংখ্যা তত বাড়তে থাকবে!

যেমন:

$1 \div 0.1 = 10$ টি টুকরো, $1 \div 0.01 = 100$ টি টুকরো, $1 \div 0.001 = 1000$ টি টুকরো, $1 \div 0.000001 = 10,00,000$ (দশ লাখ) টি টুকরো!

খেয়াল করে দেখো, আমরা ভাগ করার সংখ্যাটিকে (হর) পরম শূন্যের (0) যত কাছাকাছি নিয়ে যাচ্ছি, ভাগের উত্তরটি তত দ্রুত বড় হতে হতে আমাদের কল্পনার সীমানা ছাড়িয়ে যাচ্ছে। আর ঠিক এই মুহূর্তেই গণিত আমাদের এক অদ্ভুত সত্যের মুখোমুখি দাঁড় করায়: কোনো কিছুকে যখন প্রায় শূন্য দিয়ে ভাগ করা হয়, তখন তার মান ধাবিত হয় অসীম (Infinity)-এর দিকে।

অর্থাৎ, শূন্যের ভেতর দিয়েই অসীমের জন্ম। আমরা যখন কোনো কিছুকে একদম শেষ বা 'শূন্য' করে দিতে চাই, ঠিক তখনই সেখান থেকে অসীমের সূচনা হয়। শূন্য যদি হয় কোনো কিছুর সমাপ্তি বা সূচনা পয়েন্ট, তবে অসীম হলো তার সীমাহীন বিস্তার।



■ মহাবিশ্বে শূন্য ও অসীমের মহাজাগতিক রূপ

খাতার পাতায় সংখ্যা আর ছকের খেলায় যে শূন্য (0) আর অসীম (Infinity) আমরা দেখি, তারা কিন্তু কেবল গণিতবিদদের কল্পনার কোনো চিহ্ন নয়। আমরা যদি চোখ তুলে রাতের আকাশের দিকে তাকাই, দেখতে পাব—এই পুরো মহাবিশ্ব আসলে শূন্য আর অসীমের এক অদ্ভুত ক্যানভাসে আঁকা!

১. কৃষ্ণগহ্বর বা ব্ল্যাক হোল (Black Hole):

আমাদের মহাবিশ্বের সবচেয়ে রহস্যময় ও ভয়ংকর জায়গা হলো ব্ল্যাক হোল (Black Hole)। একটি বিশাল নক্ষত্র যখন তার জীবনের শেষ প্রান্তে এসে নিজের মারাত্মক অভিকর্ষের চাপে ভেঙে পড়তে থাকে, তখন তার ভেতরের সমস্ত পদার্থ বা ভর সংকুচিত হতে হতে একটি বিন্দুর দিকে যেতে থাকে।

পদার্থবিজ্ঞানের ভাষায়, সেই বিন্দুটির স্থান বা আয়তন হয়ে যায় একদম শূন্য (0 Volume)! আর একটু আগেই আমরা দেখেছি, ভরকে যখন প্রায় শূন্য আয়তন দিয়ে ভাগ করা হয়, তখন জন্ম নেয় অসীম (Infinity)। আয়তন শূন্য হওয়ার কারণে সেই বিন্দুর ঘনত্ব এবং মহাকর্ষ বল হয়ে যায় অসীম (Infinite Density & Gravity) বিজ্ঞানীরা এই জায়গাটিকে বলেন ‘সিঙ্গুলারিটি’ (Singularity) যেখানে খাতার পাতায় লেখা সেই 0 তার বাস্তব রূপ নেয়, আর আমাদের চেনা সময়, স্থান ও পদার্থবিজ্ঞানের সব নিয়ম দুমড়ে-মুচড়ে স্তব্ধ হয়ে যায়।

২. মহাশূন্যের অসীম বিস্তার (Infinite Cosmos):

এবার যদি আমরা ব্ল্যাক হোলের ভেতর থেকে বের হয়ে এসে আমাদের চারপাশে তাকাই, তবে দেখতে পাব মহাশূন্যের বিস্তার। আমাদের এই দৃশ্যমান মহাবিশ্বেই (Observable Universe) প্রায় ২ ট্রিলিয়ন (২ লাখ কোটি) গ্যালাক্সি রয়েছে! কিন্তু এই দৃশ্যমান সীমানার বাইরে কী আছে?

বিজ্ঞানীদের ধারণা, এই মহাবিশ্বের কোনো প্রান্ত বা শেষ দেয়াল নেই। অর্থাৎ, আমরা যত দূরই ভ্রমণ করি না কেন, মহাশূন্যের এই সীমানা



অসীমের দিকে প্রসারিত হয়ে চলেছে। এক পরম শূন্যতা (Vacuum) দিয়ে তৈরি এই মহাশূন্য যা নিজের মধ্যে ধারণ করে রেখেছে অসীম (Infinity) সম্ভাবনা ও জগৎ।

খাতার পাতায় সামান্য একটি গোল 'শূন্য' আর 'অসীম' (Infinity) চিহ্নটি যে আসলে আমাদের পুরো মহাবিশ্বের অস্তিত্ব আর সবচেয়ে বড় রহস্যগুলোকে পরিচালনা করছে, তা ভাবলেও গায়ে কাঁটা দেয়।

আর এই পরম বিস্ময় থেকেই মনের ভেতর এক গভীর প্রশ্ন উঁকি দেয়—গণিতের এই যে শূন্য, অসীম কিংবা মহাজাগতিক নিয়মগুলো কি মানুষ কেবল নিজের চিন্তাভাবনা দিয়ে উদ্ভাবন করেছে, নাকি আমরা জন্মানোর বহু আগে থেকেই এই বাস্তবতায় এগুলো লুকিয়ে ছিল?

আবিষ্কার নাকি অস্তিত্ব (Invention Or Existence)

■ আবিষ্কার এবং অস্তিত্ব কী?

এই প্রশ্নের উত্তর জানার আগে জানতে হবে 'আবিষ্কার' আর 'অস্তিত্ব'র মধ্যে তফাৎটা কী? কোনো কিছু প্রকৃতিতে আগে থেকেই বিদ্যমান অচেনা বা অজানা বস্তু বা সত্যতার বাস্তব উপস্থিতিই হলো অস্তিত্ব (Existence) আর মানুষ যখন প্রথমবার সেই অচেনাকে খুঁজে বের করে তখন তা আবিষ্কার।

উদাহরণস্বরূপ: প্রকৃতিতে 'কিছু না থাকা' অর্থাৎ খালি-র ধারণাটি সবসময়ই উপস্থিত ছিল, এটা অস্তিত্ব। সেই ধারণাটিকে গণিতবিদরা খুঁজে বের করার পর 'শূন্য' (0) হিসেবে রূপ দেওয়াটা হলো আবিষ্কার।

এখন এই 'আবিষ্কার' এবং 'অস্তিত্ব' শব্দ দুটি থেকে দুটি প্রশ্ন মাথায় আসে, সেটি হলো—

১. আমরা যা কিছু পড়ি বা হিসাব করি, সবকিছুরই কি বাস্তবে অস্তিত্ব আছে?

গণিতে এমন বহু ধারণা ও সমীকরণ আছে, যা আমরা নিয়মিত গবেষণায় ব্যবহার করি কিন্তু ভৌত জগতে বা খালি চোখে তাদের সরাসরি কোনো অস্তিত্ব খুঁজে পাওয়া যায় না। গণিতবিদরা অনেক সময় নিখুঁত যুক্তি ও কল্পনার ওপর ভর করে এমন কিছু সমীকরণ তৈরি করেন, যা আপাতদৃষ্টিতে অবাস্তব মনে হলেও প্রকৃতির গভীর রহস্য খুলে দেয়।

- অবাস্তব সংখ্যা এবং ইউলারের সমীকরণ (Euler's Identity):

গণিতে আমরা $\sqrt{-1}$ কে i দিয়ে প্রকাশ করি, যাকে বলা হয় 'কাল্পনিক সংখ্যা' (Imaginary Number)। বাস্তবে এমন কোনো বস্তু বা সংখ্যা নেই যার বর্গ করলে উত্তর ঋণাত্মক (মাইনাস) আসবে। অথচ এই অবাস্তব সংখ্যার ওপর ভিত্তি করেই দাঁড়িয়ে আছে গণিতের সবথেকে সুন্দর সমীকরণ— ইউলারের আইডেন্টিটি (Euler's Identity):

$$e^{i\pi} + 1 = 0$$

এখানে e , i এবং π এর মতো একেবারে ভিন্ন জগতের তিনটি গাণিতিক ধ্রুবক এক জায়গায় এসে মিলে গেছে! বাস্তব জগতে i এর কোনো হাত-পা না থাকলেও, এই সমীকরণ ছাড়া আজকের মোবাইল নেটওয়ার্ক, কোয়ান্টাম ফিজিক্স কিংবা ইলেকট্রিক সার্কিটের নকশা করা অসম্ভব।

আইনস্টাইনের ক্ষেত্র সমীকরণ ও বহুমাত্রিক স্থান (Einstein Field Equations & 4D):

আমরা ৩-মাত্রার (3D) জগতে বাস করি—দৈর্ঘ্য, প্রস্থ ও উচ্চতা। কিন্তু অ্যালবার্ট আইনস্টাইন তাঁর সাধারণ আপেক্ষিকতার সূত্রে আইনস্টাইনের ক্ষেত্র সমীকরণ (Einstein Field Equations) দিয়ে দেখিয়েছেন যে সময় হলো চতুর্থ মাত্রা:

$$G_{\mu\nu} + \lambda g_{\mu\nu} = \frac{8\pi G}{c^4} T_{\mu\nu}$$

এই সমীকরণে স্পেস এবং টাইম মিলে ৪-মাত্রার একটি অদৃশ্য জাল বা 'স্পেস-টাইম ফেব্রিক' তৈরি করে। আমরা খালি চোখে ৩-মাত্রার বেশি কিছু দেখতে পাই না, কিন্তু এই ৪-মাত্রিক সমীকরণই ব্ল্যাক হোল ও মহাবিশ্বের মহাকর্ষকে একদম নিখুঁতভাবে ব্যাখ্যা করে।

২. যা কিছু বাস্তবে অস্তিত্বশীল, সেই সবকিছুই কি আমরা জানি?

একদমই নয়! প্রকৃতি এবং বিশ্বব্রহ্মাণ্ড তার বুকে অগণিত রহস্য লুকিয়ে রেখেছে, যার খুব সামান্য অংশই মানুষের জ্ঞানে ধরা পড়েছে। এমন অনেক বাস্তব ঘটনা আছে যা আমাদের চোখের সামনে ঘটে, কিন্তু আজ পর্যন্ত কোনো গণিতবিদ বা বিজ্ঞানী তাদের গাণিতিক নিয়ম সম্পূর্ণ উন্মোচন করতে পারেননি।

মৌলিক সংখ্যার অগোছালো রহস্য ও রিমান হাইপোথিসিস (Prime number & Riemann Hypothesis):

২, ৩, ৫, ৭, ১১, ১৩—এই মৌলিক সংখ্যাগুলো বাস্তবে প্রতিটি গণনার ভিত্তি। কিন্তু এদের আসার মধ্যে কোনো নির্দিষ্ট নিয়ম বা সূত্র নেই। ১৮৫৯ সালে বিজ্ঞানী বার্নহার্ড রিমান জিটা ফাংশন (Riemann Zeta Function) নামের একটি সমীকরণ উপস্থাপন করেন:

$$\zeta(s) = \sum_{n=1}^{\infty} (1/n^s) = \frac{(1)}{(1^s)} + \frac{(1)}{(2^s)} + \frac{(1)}{(3^s)} + \dots$$

তিনি দাবি করেন, এই সমীকরণের মান যখন শূন্য ($\zeta(s) = 0$) হয়, তখন তার মূল সমাধানগুলো (s) একটি বিশেষ সোজা কাল্পনিক রেখায় অবস্থান করে এবং এর ভেতরেই মৌলিক সংখ্যার বিন্যাসের রহস্য লুকিয়ে আছে। এটিই বিখ্যাত ‘রিমান হাইপোথিসিস’। কিন্তু আজ ১৬০ বছরেরও বেশি সময় পার হয়ে গেলেও বিশ্বের কোনো গণিতবিদ সমীকরণটি ১০০% সত্যি কি না তা প্রমাণ করতে পারেননি!

* প্রবাহিত পদার্থের গোলকধাঁধা ও নাভিয়ের-স্টোকস সমীকরণ (Navier -Stokes Equations):

আমাদের চারপাশে নদী বা পাইপের জলপ্রবাহ, ঝড়ের বাতাস কিংবা কফিতে দুধ মেশানোর সময় সৃষ্ট ঢেউ—এগুলো সবই বাস্তব ঘটনা। এই তরল ও গ্যাসের গতি ব্যাখ্যা করার জন্য বিজ্ঞানীরা ব্যবহার করেন নাভিয়ের-স্টোকস সমীকরণ (Navier -Stokes Equations):

$$\rho \left(\frac{\partial u}{\partial t} + (u \cdot \nabla)u \right) = -\nabla p + \mu \nabla^2 u + f$$

$$\nabla \cdot u = 0$$

বাস্তবে আমরা প্রতিনিয়ত জল আর বাতাস স্পর্শ করছি, কিন্তু বিষম বিস্ময়ের বিষয় হলো—গাণিতিকভাবে আজও কেউ প্রমাণ করতে পারেনি যে এই সমীকরণটি সব পরিস্থিতিতে (যেমন তীব্র ঝড় বা উত্তাল তরঙ্গে) সবসময় সঠিক ও মসৃণ উত্তর দেবে, নাকি কোনো একবিন্দুতে গিয়ে অসীম (Infinity) হয়ে ভেঙে পড়বে!

এই মহাবিশ্বে যা কিছু অস্তিত্বশীল, তার অতি ক্ষুদ্র এক ভগ্নাংশই কেবল আমরা জানতে পেরেছি। গণিত নামক মহাসমুদ্রের তীরে দাঁড়িয়ে আমরা এখনো অজানা রহস্যের নুড়িপাথর কুড়িয়ে চলেছি।

গণিতহীন পৃথিবী (World Without Mathematics) :

সময় ও তারিখের বিলুপ্তি: ঘড়ি, ক্যালেন্ডার বা সময় পরিমাপের সুযোগ থাকবে না। ফলে মানুষের দৈনন্দিন সময়সূচি, কাজের তাগিদ ও ভবিষ্যৎ পরিকল্পনার অস্তিত্ব মুছে যাবে।

আধুনিক প্রযুক্তির অবসান: কম্পিউটার, ইন্টারনেট ও স্মার্টফোন বাইনারি পদ্ধতি (০ ও ১) এবং অ্যালগরিদমের ওপর নির্ভরশীল। গণিত ছাড়া আধুনিক কোনো ইলেকট্রনিক ডিভাইসের অস্তিত্ব সম্ভব নয়।

অবকাঠামো ও স্থাপত্যের পতন: জ্যামিতিক পরিমাপ এবং কাঠামোগত হিসাব ছাড়া বহুতল ভবন, দীর্ঘ সেতু বা জটিল উড়ালপুল তৈরি করা অসম্ভব হয়ে পড়বে।

অর্থনৈতিক ব্যবস্থার বিনাশ: ব্যাংক, মুদ্রা, শেয়ারবাজার এবং ডিজিটাল লেনদেনের মূল ভিত্তি হিসাব-নিকাশ। গণিত না থাকলে শৃঙ্খলিত বাণিজ্য ব্যবস্থা ভেঙে পড়ে মানবজাতি আদিম যুগের অনিশ্চিত বিনিময় প্রথায় ফিরে যাবে।

বিজ্ঞান ও চিকিৎসা ব্যবস্থার পক্ষাঘাত: পদার্থবিজ্ঞান ও রসায়নের সব সূত্র থমকে যাবে। ওষুধের সুনির্দিষ্ট মাত্রা (ডোজ) নির্ধারণ বা আধুনিক রোগ নির্ণয়কারী যন্ত্র পরিচালনা করা অসম্ভব হবে।

শিল্প ও প্রকৃতির ছন্দপতন: গানের তাল-লয়, চিত্রকলার সঠিক ক্যানভাস অনুপাত এবং প্রকৃতির নিজস্ব গঠন (যেমন শামুকের খোল বা ফুলের পাপড়ির ফিবোনাচ্চি প্যাটার্ন) বোঝার গাণিতিক সক্ষমতা মানুষ হারিয়ে ফেলবে।

উপসংহার (Conclusion):

মাকড়সার জালের সূক্ষ্ম জ্যামিতিক বুনন থেকে শুরু করে ‘শূন্য’ (০) দিয়ে অসীম মহাবিশ্বকে পরিমাপ করার ক্ষমতা—গণিত কেবল একটি বিষয় নয়, বরং প্রকৃতির এক অবিচ্ছেদ্য ভিত্তি। গণিত মানুষের তৈরি কোনো আবিষ্কার, নাকি প্রকৃতির বুকে আগে থেকেই লুকিয়ে থাকা কোনো পরম সত্য—সেই দার্শনিক উত্তর যাই হোক না কেন, গণিত ছাড়া এই পৃথিবীর অস্তিত্ব কল্পনা করাই অসম্ভব।

গণিতহীন বিশ্ব মানেই এক দিশাহীন সভ্যতা, যেখানে বিজ্ঞান, স্থাপত্য, প্রযুক্তি ও শিল্প সবকিছুই নিস্তব্ধ হয়ে পড়ে। ক্লাসরুমের সংখ্যা আর সূত্রের গণ্ডি পেরিয়ে গণিত হলো আসলে এই মহাবিশ্বের নিজস্ব ছন্দ ও ভাষা। ক্ষুদ্রতম পরমাণু থেকে দূরান্তরের নক্ষত্রপুঞ্জকে এক সূত্রে বেঁধে রাখা এই অদৃশ্য ভিত্তিটি আছে বলেই আমাদের পৃথিবী আজ এত সুশৃঙ্খল, সুন্দর ও গতিশীল। আসলে শূন্যকে যদি দেখো তাহলে সে কিছুই না কিন্তু শূন্যের মধ্যে দিয়ে যদি দেখো তাহলে পুরো বিশ্ব দেখা যায় |

ZERO GALLERY: THE NOTHING THAT IS—A JOURNEY INTO THE ORIGINS OF ZERO



- Deepak Kumar
Department of Mathematics
Semester - III

Mathematics is often thought of as a world of rigid formulas and endless calculations, but our recent visit to Zero Gallery: The Nothing That Is shattered that notion. Organized by the Department of Mathematics, City College, on December 19, 2024, this trip was an eye-opening exploration of the fascinating history of zero—an unsung hero in the evolution of mathematics.

From the very start, excitement filled the air as we set off, eager to uncover the mysteries behind one of the most fundamental concepts in mathematics. Upon arrival, we were warmly welcomed by Prof. Parthasarathi Mukhopadhyay, the visionary behind the gallery. Accompanied by our HOD Dr. Masiur Rahaman Sardar and professors Dr. Rita Chanda, Uttam Kumar Bera, and Mr. Syamsundar Dhara, we received an insightful introduction from Prof. Mukhopadhyay himself. His passion for the subject was evident as he took us through the journey of zero's origin and impact

Zero Gallery: The Nothing That Is is a haven for anyone curious about the birth and evolution of this crucial mathematical concept. The exhibits presented an extensive range of historical facts, illustrating how zero transitioned from a simple placeholder to a foundational pillar of modern mathematics. One of the most intriguing sections was the detailed exploration of the Maya civilization's concept of zero, which offered a fresh perspective on how ancient cultures played a role in shaping numerical systems.



Department Of Mathematics , City College With Prof. Parthasarathi Mukhopadhyay Inside the Zero Gallery



Some Interesting Facts About the Maya Civilisation

Prof. Mukhopadhyay's explanations brought these historical milestones to life. We learned about zero's journey through ancient Indian, Babylonian, and Egyptian mathematics, as well as its indispensable role in fields like algebra, calculus, and computer science. His storytelling transformed what could have been a dry history lesson into a thrilling narrative of discovery.

Before heading to the Museum of Environment and Man, we took a serene detour through the Ramakrishna Mission Ashram, Narendrapur campus. Surrounded by lush greenery and a tranquil atmosphere, the walk through the ashram provided a moment of reflection, setting the perfect tone for the historical and philosophical insights that awaited us at the museum.

In addition to our visit to Zero Gallery, we also explored the Museum of Environment and Man, where we marveled at remarkable artifacts such as the Ashoka Lion Capital from the 3rd century BC and a stunning depiction of Buddha with his disciples from the 2nd century BC, among many others.

Beyond the intellectual engagement, the trip was a blend of fun and camaraderie. As we wandered through the exhibits, discussing and debating the significance of zero, we realized how much we had taken this concept for granted. We



In front of the Museum of Environment and Man with our professors

snapped photos, exchanged insights, and even joked about how life without zero would be unimaginable—quite literally!



Some Artifacts from The Museum of Environment and Man

As we stepped out of Zero Gallery: The Nothing That Is, we carried with us a deeper sense of wonder and curiosity. The trip had not only enriched our understanding of zero but also sparked a greater appreciation for the intricate connections between mathematics and human civilization. It was a reminder that mathematics is more than just numbers; it is a story of discovery, a bridge between cultures, and a testament to humanity's quest for knowledge.

Zero might signify nothing, but this experience was everything.

PROOFS WITHOUT WORDS

Pinaki Nandy

Department of Mathematics

Semester -VI



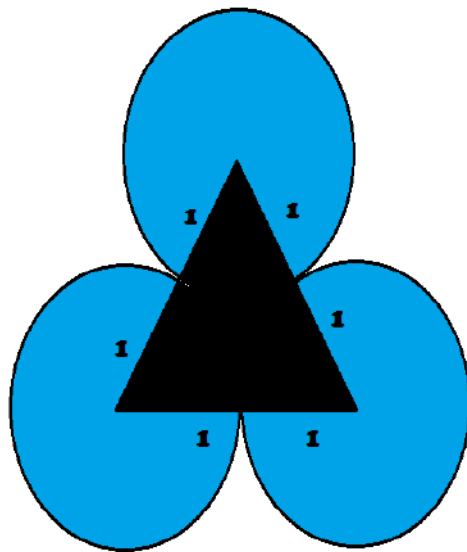
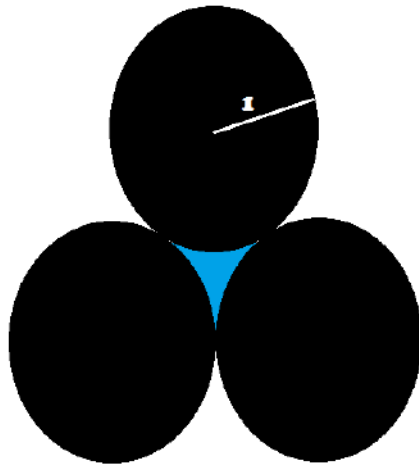
“Proofs without words” featuring visual proof of mathematical concepts, was first introduced by Roger B. Nelson in a mathematical magazine in 1975 published by Mathematical Association of America.

In mathematics, proofs are traditionally expressed using written symbols and logical steps. However, some theorems can be elegantly demonstrated by visual representations, where structure and arrangements of shapes, numbers, or graphs convey the truth of the statement without the need for verbal explanation.

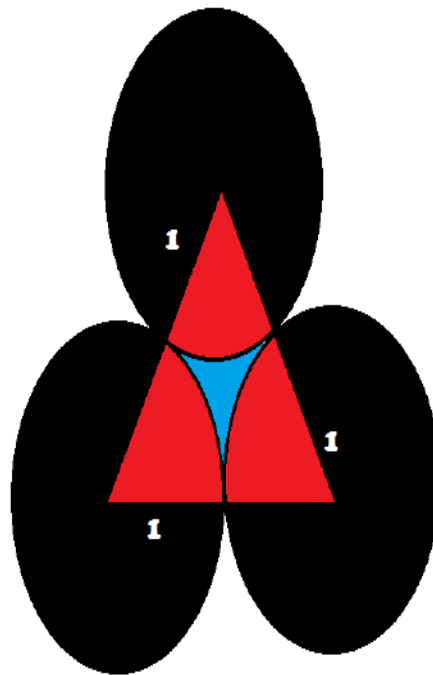
Some examples:

Draw three mutually tangent unit circles. Find the area of highlighted region by blue.

PROOFS WITHOUT WORDS



PROOFS WITHOUT WORDS

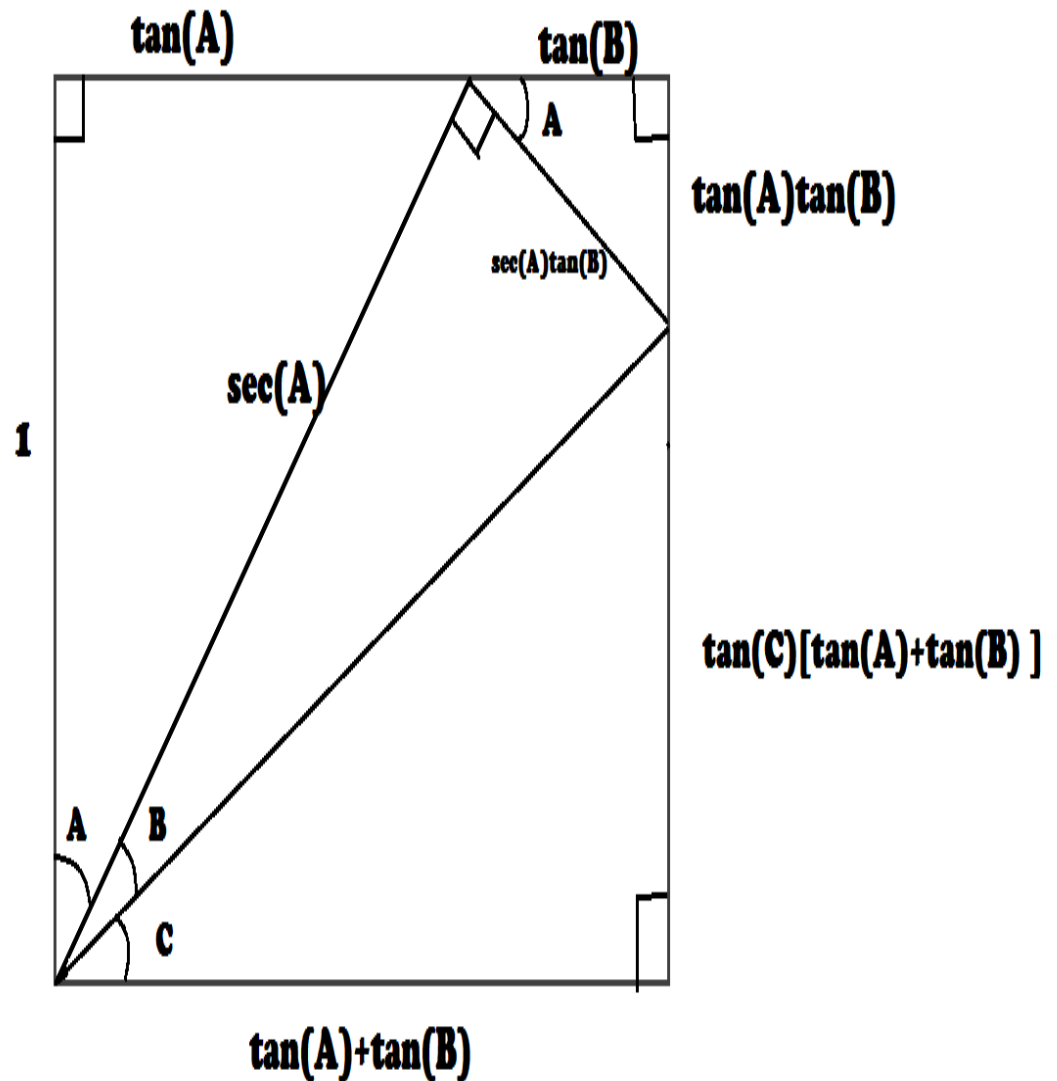


$$\begin{aligned}
 \text{(Blue region)} &= \text{(Black triangle)} - 3 * (\text{Red sector}) \\
 &= 3^{1/2} - 3 * \text{pie}/6
 \end{aligned}$$

PROOFS WITHOUT WORDS

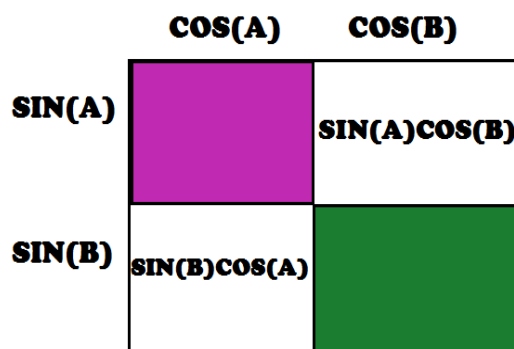
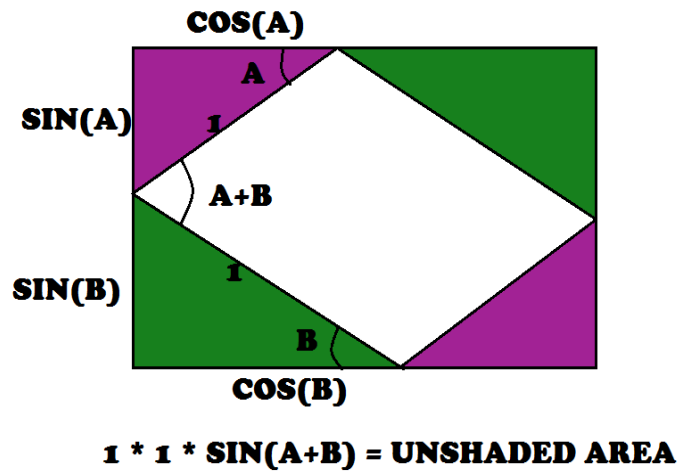
A sum of tangent products:

If A, B, C are any positive angles such that $A+B+C = \pi/2$, then $\tan A \tan B + \tan B \tan C + \tan C \tan A = 1$



PROOFS WITHOUT WORDS

Sine of a sum: $\sin(A+B) = \sin(A) \cos(B) + \cos(A) \sin(B)$



$$\sin(A+B) = \sin(A)\cos(B) + \sin(B)\cos(A)$$

BHASKARACHARYA: “THE ANCIENT INDIAN MATH GENIUS”

Name : Bhashkar Karmakar

Department :MTMA

Sem :6



Bhaskaracharya, also known as Bhaskara II, was a renowned Indian mathematician and astronomer of the 12th century.

He was born in 1114 CE in Bijapur, Karnataka, India, and belonged to the Deshastha Brahmin community.

Bhaskaracharya wrote this influential mathematical treatise, which covers various mathematical concepts, including arithmetic, algebra, geometry, and trigonometry.

This treatise focuses on algebra and covers topics like equations, quadratic equations, and algebraic methods for solving equations.



He was not only a mathematician but also a great astronomer .

Siddhanta Shiromani: A comprehensive astronomy text that discusses planetary positions, eclipses, and astronomical calculations.

CONTRIBUTION IN MATHEMATICS

Bhaskaracharya's contributions to mathematics have had a lasting impact, and his ideas continue to influence modern mathematics. Here are some of his contributions that are still relevant in modern math:

Algebra:

1. **Zero and Infinity:** Bhaskaracharya was one of the first mathematicians to recognize and utilize zero and infinity in mathematical calculations. This concept is fundamental to modern algebra and calculus.
2. **Algebraic Methods:** He developed algebraic methods for solving equations, including the concept of negative numbers. These methods are still used in modern algebra.
3. **Quadratic Equations:** Bhaskaracharya solved quadratic equations using algebraic methods, which is still a fundamental concept in modern algebra.

Number Theory:

1. **Pell's Equation:** Bhaskaracharya studied the equation $x^2 = 1 + ny^2$, now known as Pell's equation. This equation is still an important area of research in number theory.
2. **Congruences:** He worked on congruences, which are still a fundamental concept in number theory.

Calculus:

1. **Concept of Derivative:** Bhaskaracharya's work on the concept of "uttara" (which roughly translates to "difference") is similar to the modern concept of a derivative.
2. **Method of Indivisibles:** He used a method called "indivisibles" to calculate areas and volumes, which is similar to the modern method of integration.

Trigonometry:

1. **Sine, Cosine ,and Tangent:** Bhaskaracharya calculated the values of sine, cosine, and tangent for various angles, which is still a fundamental concept in trigonometry.
2. **Trigonometric Identities:** He discovered several trigonometric identities, including the Pythagorean identity $\sin^2(x) + \cos^2(x) = 1$.

INFLUENCE ON LATER MATHEMATICIANS

Bhaskaracharya's works had a significant impact on later mathematicians, including:

1. **Madhava of Sangamagrama:** A 14th-century Indian mathematician who built upon Bhaskaracharya's work on calculus and number theory.
2. **European Mathematicians:** Bhaskaracharya's works were translated into Persian and Arabic, and later influenced European mathematicians such as Fibonacci and Regiomontanus.

Overall, Bhaskaracharya's contributions to mathematics have had a lasting impact, and his ideas continue to influence modern mathematics.

ASTRONOMICAL CONTRIBUTIONS:

1. **Planetary Positions:** Bhaskaracharya accurately calculated planetary positions and developed methods for predicting eclipses.

2. **Astronomical Calculations:** His works provide detailed astronomical calculations, including calculations of solar and lunar eclipses.

Legacy:

Bhaskaracharya's contributions to mathematics and astronomy had a profound impact on the development of these fields in India and beyond. His works were widely studied and respected in the Middle Ages and continue to influence mathematical and astronomical research to this day.

2025 : A YEAR OF MATHEMATICAL WONDERS



- RITTIK PAL , MATHEMATICS HONOURS , EX STUDENT (2021 -2024)

HAPPY NEW YEAR 2025!

Each year brings a unique number to celebrate, and with every number comes the opportunity to explore its mathematical expressions. This article dives into the many creative ways to represent the number 2025. Perfect for students, teachers and anyone who loves maths, these examples aim to spark curiosity and encourage a deeper appreciation for numbers.

>>

>> Let's uncover what makes "2025" uniquely interesting in the world of mathematics.

1. From its structure as a perfect square ($45^2 = 2025$) to its digits that spark curiosity when analyzed through number theory. 2025 invites us to explore the wonders of mathematics in a way that is both joyful and thought provoking. This introduction embarks on a journey through the mathematical lenses of patterns, curiosities, and the deeper meanings embedded in this remarkable number, reminding us of the universal beauty of mathematics as we celebrate a new beginning.

2. Representation of 2025 using the digits 1 to 9 exactly once :-

$$2025 = 12 * 3 + (4 + 5) * (6 * 7) * (8 + 9)$$

$$2025 = 9 * 8 + 76 + 5^4 * 3 + 2 * 1$$

3. Representation of 2025 using the numbers 1 to 10 exactly once :-

$$2025 = 12 * 3 + 45 * 6 * 7 + 89 + 10$$

$$2025 = 10 + (9 + 8 * 76 + 54) * 3 + 2 * 1$$

4. Representation of 2025 using the numbers 1,2,3,...,9 and square function :-

$$2025 = \{(-9 + 8 + 7)^2 - 6 + 5 + 4 + 3 + 2 + 1\}^2$$

$$2025 = \{-1 + 2 + (3)^2 + 4 + 5 + 6 + 7 + 8 + 9\}^2$$

5. Representation of 2025 using the numbers 1,2,3,...,9 and cube function :-

$$2025 = -9 + (8 + 7)^3 - (6 + 5)^3 - 4 - 3 - 2 - 1$$

$$2025 = -1 + 2 * (3^3 + 4^3) * (5 + 6) + 7 + 8 + 9$$

6. Representation of 2025 using the numbers 1,2,3,...,9 and factorial :-

$$2025 = (-1-2) * (3 + 4!) * (5 - 6 - 7 - 8 - 9)$$

$$2025 = -9 * (8 + 7) + 6! * (5 + 4 - 3 - 2 - 1)$$

7. Representation of 2025 as power of 2 :-

$$2025 = 2^{10} + 2^9 + 2^7 + 2^6 + 2^5 + 2^4 - 2^3 + 2^0$$

8. Representation of 2025 using its own digits in the given order :-

$$2025 = (202 * 5) * 2 + 0 * 2 + 5$$

$$2025 = (20 * 25) * (2 + 0 * 2 * 5)^{(2 + 0 * 2 * 5)} + 2 * 0 + 25$$

9. Running equally for 2025 using various mathematical operations :-

$$2025 = 9 - (8!/7) + 6^5 = (43 + 2)^1$$

10. 2025 is equal to each of the following :-

$$2025 = 45^2 = (20 + 25)^2$$

$$2025 = (3^2 + 6^2)^2$$

$$2025 = (1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9)^2$$

11. 2025 as a sum of squares :-

$$2025 = 729 + 1296 = 27^2 + 36^2$$

12. 2025 as a sum of cubes :-

$$2025 = 1^3 + 2^3 + 3^3 + 4^3 + 5^3 + 6^3 + 7^3 + 8^3 + 9^3$$

13. 2025 as a sum of consecutive natural numbers :-

$$2025 = 1012 + 1013$$

$$2025 = 674 + 675 + 676$$

$$2025 = 403 + 404 + 405 + 406 + 407$$

$$2025 = 335 + 336 + 337 + 338 + 339 + 340$$

$$2025 = 221 + 222 + 223 + 224 + 225 + 226 + 227 + 228 + 229$$

$$2025 = 198 + 199 + 200 + 201 + 202 + 203 + 204 + 205 + 206 + 207$$

14. Representation of 2025 as powers of consecutive numbers :-

$$2025 = -1^5 - 2^2 + 3^6 + 4^1 + 5^0 + 6^4$$

$$2025 = 1^7 + 2^0 + 3^6 + 4^5 + 5^1 + 6^3 + 7^2$$

$$2025 = 1^7 + 2^8 + 3^6 + 4^0 + 5^4 + 6^1 + 7^3 + 8^2$$

$$2025 = -1^3 + 2^7 - 3^8 - 4^9 + 5^4 + 6^5 + 7^2 + 8^6 + 9^1$$

$$2025 = -1^9 + 2^6 - 3^8 + 4^3 + 5^4 + 6^5 + 7^2 + 8^1 + 9^0$$

15. A few Pythagorean triples with the number 2025 :-

$$2025^2 + 156^2 = 2031^2$$

$$2025^2 + 2968^2 = 3593^2$$

$$2025^2 + 1080^2 = 2295^2$$

$$2025^2 + 2700^2 = 3375^2$$

$$2025^2 + 2448^2 = 3177^2$$

16. Below we present the values of various powers of $2025 = (20 + 25)^2$.

Look at the same digits on both sides of the equality :-

$$(20 + 25)^2 = 2025 = (20 + 25)^2$$

$$(20 + 25)^3 = 91125 = (9 + 11 + 25)^3$$

$$(20 + 25)^4 = 4100625 = (4 + 10 + 06 + 25)^4$$

$$(20 + 25)^5 = 184528125 = (18 - 45 - 2 + 81 - 2 - 5)^5$$

$$(20 + 25)^6 = 8303765625 = (8 - 30 + 37 - 6 + 5 + 6 + 25)^6$$

17. Adding to 2025 its reverse ($= 5202$), we get a palindrome ($= 7227$).

18. Single digit representation of 2025 :-

***** Using only 1 :-**

$$2025 = (1 + 1)^{(1 + 1)/1} - [1 + (11 + 11)]$$

$$2025 = [\{(1 + 1 + 1 + 1) * 11/1 + 1\}/1]^{(1 + 1)/1}$$

$$2025 = \{(1111 - 111 + 11 + 1) * (1 + 1)/1 + 1\}/1$$

***** Using only 2 :-**

$$2025 = (2 * 22 + 2/2)^2$$

$$2025 = [\{(2 + 2 + 2 + 2) * 22/2 + 2\}/2]^{(2 + 2)/2}$$

$$2025 = \{(2222 - 222 + 22 + 2) * (2 + 2)/2 + 2\}/2$$

***** Using only 3 :-**

$$2025 = 3 * [3 * (3 + 3)^3 + 3^3]$$

$$2025 = [\{ (3 + 3 + 3 + 3) * 33/3 + 3 \} / 3] ^ { (3 + 3) / 3 }$$

$$2025 = \{ (3333 - 333 + 33 + 3) * (3 + 3) / 3 + 3 \} / 3$$

***** Using only 4 :-**

$$2025 = (44 + 4/4) ^ { (4 + 4) / 4 }$$

$$2025 = [\{ (4 + 4 + 4 + 4) * 44/4 + 4 \} / 4] ^ { (4 + 4) / 4 }$$

$$2025 = \{ (4444 - 444 + 44 + 4) * (4 + 4) / 4 + 4 \} / 4$$

***** Using only 5 :-**

$$2025 = 5 * [5 * (5 * 5 + 55) + 5]$$

$$2025 = [\{ (5 + 5 + 5 + 5) * 55/5 + 5 \} / 5] ^ { (5 + 5) / 5 }$$

$$2025 = \{ (5555 - 555 + 55 + 5) * (5 + 5) / 5 + 5 \} / 5$$

***** Using only 6 :-**

$$2025 = 6 * 6 * 6 * 6 + [(6 * 6) / (6 + 6)] ^ { (6 + 6 + 6) / 6 }$$

$$2025 = [\{ (6 + 6 + 6 + 6) * 66/6 + 6 \} / 6] ^ { (6 + 6) / 6 }$$

$$2025 = \{ (6666 - 666 + 66 + 6) * (6 + 6) / 6 + 6 \} / 6$$

***** Using only 7 :-**

$$2025 = (7/7 + 7 + 7) * [\{ (7 + 7) / 7 \} ^ 7 + 7]$$

$$2025 = [\{ (7 + 7 + 7 + 7) * 77/7 + 7 \} / 7] ^ { (7 + 7) / 7 }$$

$$2025 = \{ (7777 - 777 + 77 + 7) * (7 + 7) / 7 + 7 \} / 7$$

***** Using only 8 :-**

$$2025 = 8/8 + [88 * \{(8 - 8/8 + 8) + 8\}]$$

$$2025 = [\{(8 + 8 + 8 + 8) * 88/8 + 8\}/8]^{(8 + 8)/8}$$

$$2025 = \{(8888 - 888 + 88 + 8) * (8 + 8)/8 + 8\}/8$$

***** Using only 9 :-**

$$2025 = 9 * [(9 + 9) * (9 * 9) - 99]$$

$$2025 = [\{(9 + 9 + 9 + 9) * 99/9 + 9\}/9]^{(9 + 9)/9}$$

$$2025 = \{(9999 - 999 + 99 + 9) * (9 + 9)/9 + 9\}/9$$

19. A Magic Square of third order with Magic Sum 2025 :-

Sum of each row :-

$$1080 + 135 + 810 = 2025$$

$$405 + 675 + 945 = 2025$$

$$540 + 1245 + 270 = 2025$$

1080	135	810
405	675	945
540	1245	270

Sum of each column :-

$$1080 + 405 + 540 = 2025$$

$$135 + 675 + 1245 = 2025$$

$$810 + 945 + 270 = 2025$$

Sum of diagonals :-

$$1080 + 675 + 270 = 2025$$

$$810 + 675 + 540 = 2025$$

20. Harshad Number :-

$2 + 0 + 2 + 5 = 9$ and $2025 / 9 = 225$. Since 2025 is divisible by the sum of its digits (9), it qualifies as a Harshad Number.

21. Sum of the first 45 odd numbers :-

$$2025 = 1 + 3 + 5 + 7 + \dots + 89$$

22. Triangular Square :-

$45 = (9 * 10) / 2$; 2025 is the square of 45 , which is also the 9 th triangular number.

Come on, let's celebrate and live this year 2025 hope this year will add joy, subtract sorrow , multiply happiness and divide our love among everyone living in this world.

The Origin and Value of Algebra in the Modern World

Sahil huda

B.Sc. Mathematics Honours-Semester VI

Introduction

Algebra, as a branch of mathematics, has a rich history that dates back to ancient civilizations. Its development has played a critical role in shaping the modern world, impacting various fields such as science, technology, engineering, and finance. This report explores the origins of algebra, its evolution, and its significance in contemporary society.

Historical Origins of Algebra

(1) Ancient Babylon

Algebra originated in ancient Babylon around 2000 BCE. The Babylonians employed algebraic methods to solve practical problems and equations using a base-60 numeral system. They documented their techniques on clay tablets, including the well-known Plimpton 322 tablet, which contains a table of Pythagorean triples, showcasing their advanced understanding of number theory

([britannica.com])(https://www.britannica.com/science/mathematics/Ancient-mathematical-sources?utm_source=openai)).

(2) Ancient Egypt

In ancient Egypt, algebraic methods were used primarily for practical purposes such as distribution and construction. The Rhind Mathematical Papyrus (circa 1650 BCE) illustrates their approach to solving linear equations through the “method of false position” ([cuemath.com])(https://www.cuemath.com/learn/mathematics/algebra-history-of-algebra/?utm_source=openai)).

(3) Greek Contributions

Greek mathematicians made significant contributions to algebra. Euclid’s “Elements” provided geometrical solutions to quadratic equations, while Diophantus of Alexandria, often referred to as the “Father of Algebra,” introduced an early form of algebraic symbolism in his work “Arithmetica,” focusing on integer solutions

([britannica.com](https://www.britannica.com/science/mathematics/Ancient-mathematical-sources?utm_source=openai)).

(4) Islamic Golden Age

During the Islamic Golden Age, Persian mathematician Al-Khwarizmi made foundational contributions to algebra. His seminal work, “Al-Kitāb al-mukhtaṣar fī ḥisāb al-jabr wa’l-muqābala” (“The Compendious Book on Calculation by Completion and Balancing”), introduced systematic methods for solving linear and quadratic equations. The term “algebra” is derived from “al-jabr,” one of the operations described in this book ([britannica.com](https://www.britannica.com/biography/al-Khwarizmi?utm_source=openai)).

Summary of Historical Development

The evolution of algebra from Babylonian clay tablets to Al-Khwarizmi’s systematic methods demonstrates how mathematical concepts have been refined across cultures and centuries. Each civilization built upon previous knowledge, gradually transforming algebra from practical problem-solving techniques into a formal mathematical discipline with its own notation and methodology.

The Role of Algebra in the Modern World

- Education and Cognitive Development

Algebra plays a critical role in education, particularly in enhancing students’ problem-solving abilities and logical reasoning. Research indicates that integrating algebra education with critical thinking significantly improves students’ mathematical skills. For instance, a study by Mursalin at Universitas Malikussaleh found that students using elementary algebra e-books demonstrated superior mathematical critical thinking skills compared to those using conventional textbooks

([ojs.unimal.ac.id](https://ojs.unimal.ac.id/index.php/mjml/article/view/2292/0?utm_source=openai)).

- Technological Applications

Algebra underpins various technological advancements and applications in our increasingly digital world:

- Computing and Information Technology

-Computer Science: Algebraic structures and algorithms are essential for data types, computational complexity, and algorithm design

([medium.com](https://medium.com/%40muhammadsanwal_26747/the-power-of-algebra-in-technology-3b94605ba961?utm_source=openai)).

Coding Theory: Techniques from algebra are used in error-correcting codes, cryptography, and data compression, ensuring secure and efficient data transmission ([medium.com](https://medium.com/%40muhammadsanwal_26747/the-power-of-algebra-in-technology-3b94605ba961?utm_source=openai)).

- Visual Computing and Design
Computer Graphics: Algebraic methods facilitate geometric modeling, transformations, and rendering processes that power modern video games, animation, and design software ([medium.com](https://medium.com/%40muhammadsanwal_26747/the-power-of-algebra-in-technology-3b94605ba961?utm_source=openai)).
- Artificial Intelligence and Data Science

Machine Learning: Algebra supports neural networks, optimization techniques, and data analysis, forming the mathematical foundation of AI systems ([medium.com](https://medium.com/%40muhammadsanwal_26747/the-power-of-algebra-in-technology-3b94605ba961?utm_source=openai)).

Statistics: Algebraic tools assist in data analysis, hypothesis testing, and statistical modeling, enabling researchers to derive meaningful insights from complex datasets ([medium.com](https://medium.com/%40muhammadsanwal_26747/the-power-of-algebra-in-technology-3b94605ba961?utm_source=openai)).

- Systems and Infrastructure

Network Science: Graph theory and network analysis, grounded in algebra, are vital for understanding and optimizing complex networks from social media platforms to transportation systems ([medium.com](https://medium.com/%40muhammadsanwal_26747/the-power-of-algebra-in-technology-3b94605ba961?utm_source=openai)).

Robotics: Algebraic concepts are applied in motion planning, control theory, and robotic vision, enabling the development of increasingly sophisticated autonomous systems ([medium.com](https://medium.com/%40muhammadsanwal_26747/the-power-of-algebra-in-technology-3b94605ba961?utm_source=openai)).

Signal Processing: Algebra is used in filtering, transform methods, and signal analysis, crucial for telecommunications, audio processing, and medical imaging ([medium.com](https://medium.com/%40muhammadsanwal_26747/the-power-of-algebra-in-technology-3b94605ba961?utm_source=openai)).

- **Advances in Teaching Strategies**

Innovative teaching strategies in algebra education have been shown to foster critical thinking and enhance mathematical understanding. A study by Rahardjoni, Hasanah, and Nugraheni at Universitas Negeri Semarang revealed that junior high school students who learned algebra through augmented reality exhibited significantly higher algebraic thinking and more positive attitudes toward algebra than those in traditional settings

([journal.unnes.ac.id](https://journal.unnes.ac.id/sju/prisma/article/view/37768?utm_source=openai)).

- **Summary of Modern Applications**

The diverse applications of algebra in contemporary society highlight its versatility and foundational importance. From enhancing educational outcomes to powering cutting-edge technologies, algebraic principles continue to drive innovation across disciplines. The integration of new teaching methodologies further ensures that future generations can harness algebra's problem-solving potential.

Conclusion

The historical evolution of algebra from ancient civilizations to the modern world highlights its enduring significance. What began as practical problem-solving methods in Babylon and Egypt has transformed into a sophisticated mathematical language that underpins technological advancement and scientific discovery. Algebra not only forms the foundation of many technological innovations but also plays a crucial role in education by enhancing critical thinking and problem-solving skills. Its applications across computer science, engineering, data analysis, and numerous other fields underscore its importance in driving innovation and addressing contemporary challenges. As we continue to develop new teaching methodologies and discover novel applications, algebra's relevance in our society will only increase, cementing its status as one of humanity's most valuable intellectual achievements.

Mathematics, the language of the universe.

— ∞ —

0
1
1
2
3
5
8
13
21
34
55
89
144
...



$$F_R = F_{R-1} + F_{R-2}$$

Rittika Roy Chowdhury
BSc Mathematics Major
Semester Five



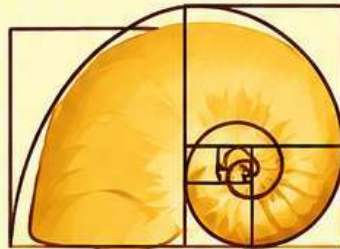
Mathematics

The Language of the Universe

The Golden Ratio

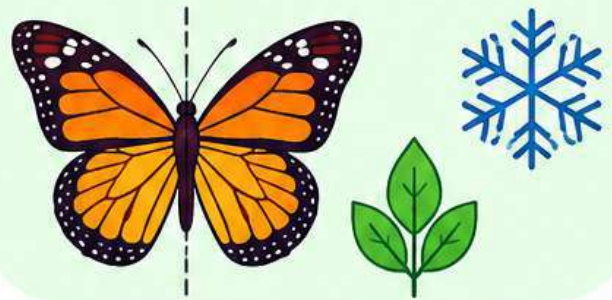
- The golden ratio ($\phi \approx 1.618$) is a special number found in nature, art and architecture.
- It creates harmony and balance in proportions.
- It appears in the spiral of shells, flowers and even galaxies.

$$\phi = \frac{1 + \sqrt{5}}{2} \approx 1.618$$



The Symmetry of Nature

- Symmetry is everywhere — in plants, animals, crystals and galaxies.
- It makes nature look beautiful, organized and balanced.
- From a butterfly's wings to a snowflake, math creates the patterns of life.



The Usefulness of Mathematics



Solves Real-World Problems

- Helps us build bridges, design cities, create technology and predict the future.



Drives Innovation

- Powers advances in science, medicine, AI, space exploration and more.



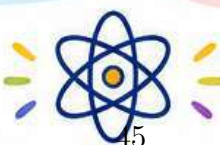
Builds Critical Thinking

- Teaches us to analyze, reason, find patterns and make better decisions.



Connects Us All

- It's the universal language that brings people, cultures and ideas together.



$$\varphi = \frac{1+\sqrt{5}}{2}$$

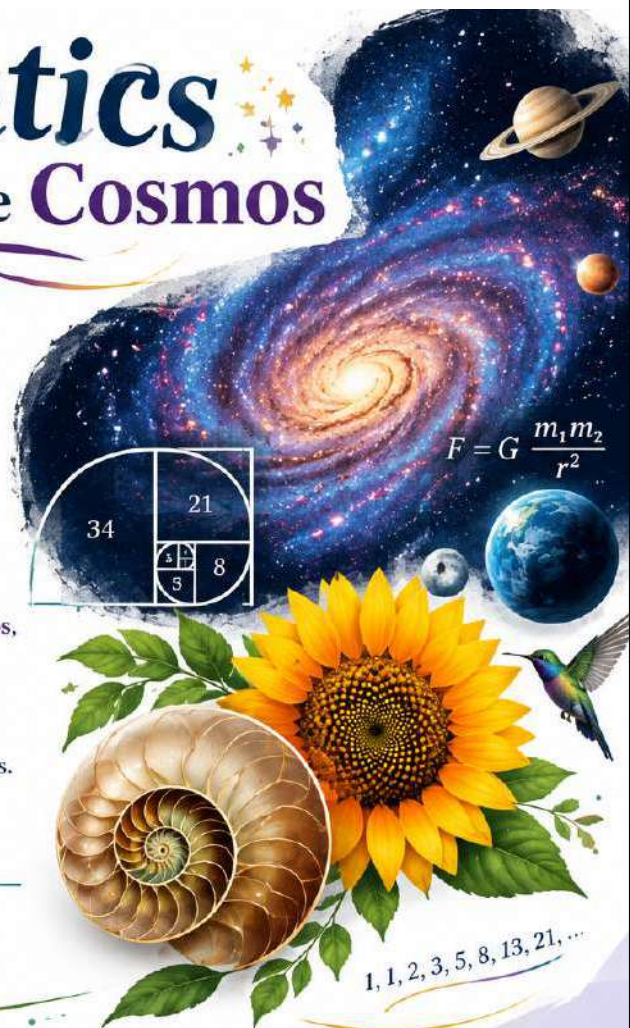
Mathematics

in the Nature and the Cosmos

Mathematics is the hidden thread that connects the **natural world** with the vastness of the **cosmos**. From the spiral of a galaxy to the pattern of a leaf, from the rhythm of ocean waves to the movement of planets, mathematical principles shape and govern the universe. It helps us describe, predict and understand the beauty, order and harmony that exist in both the smallest and the largest scales of life and existence.

In **nature**, mathematics appears in the form of patterns, symmetry, ratios and sequences. In the **cosmos**, it guides the motion of celestial bodies, the structure of galaxies and the fabric of space-time. Together, they remind us that the universe is not just a place we live in — it is a mathematical masterpiece, written in the language of numbers, shapes and patterns.

*"From the smallest atom to the largest galaxy,
mathematics is the universal language
that binds everything together."*



"Not just numbers,
but a way of seeing
the world."

Philosophical and Deeper Meanings



Logic
Reason
Truth
Reality

Mathematics is not just about numbers, equations and formulas — it is a way of thinking, a lens through which we understand the world and our place in it. On a deeper level, mathematics reveals the hidden order behind existence, the patterns that connect the smallest particles to the largest galaxies, and the logic that shapes the universe itself.

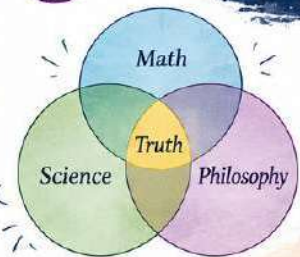
Philosophically, mathematics invites us to ask bigger questions: Why does the universe follow such precise laws? Is it just coincidence, or is there a deeper purpose? It challenges us to explore the nature of reality, the limits of human knowledge, and the connection between mind, truth and the cosmos. In many ways, mathematics is not just a subject — it is a bridge between logic and imagination, science and philosophy, the finite and the infinite.

"Mathematics is the poetry
of reason, and the key to
understanding the universe."



Big questions...

- Who are we?
- Where do we come from?
- Is there a purpose?



Different
disciplines...
One truth.

It's not just
about solving
problems...
it's about
understanding
life.

From
numbers...
to
meaning.



"The universe
speaks in symbols,
and mathematics
is its language."



Women in Mathematics



MOUMITA NAGA

B.Sc. Mathematics Major — Semester 1

Mathematics has played an important role in the development of science, technology and human civilization. It provides a language through which we can describe patterns, solve problems and understand complex systems.

Although the history of mathematics has traditionally highlighted many male mathematicians, women have also made remarkable contributions to the subject. Their work can be found in areas such as algebra, geometry, number theory, mathematical physics, statistics, astronomy and computing.

The journey of women in mathematics has not always been easy. In many periods of history, women had limited access to formal education and academic institutions. Nevertheless, several women pursued mathematics with determination and made contributions that continue to influence the subject today.

The achievements of women mathematicians show us that mathematics is a field open to anyone with curiosity, dedication and creativity.

Why is this topic important?

Learning about women in mathematics helps us:

- Recognize contributions that may have been overlooked.
- Understand the history of mathematics more completely.
- Encourage young students to pursue mathematics.
- Appreciate diversity in scientific research.

- Understand that mathematical talent is not determined by gender.

➤ A Journey Through History

5th Century — Hypatia of Alexandria

One of the earliest well-documented women associated with mathematics, astronomy and philosophy.



18th Century — Maria Gaetana Agnesi

An Italian mathematician known for her work in calculus and mathematical analysis.



19th Century — Ada Lovelace

Known for her pioneering work on Charles Babbage's Analytical Engine and often described as the first computer programmer.



19th Century — Sofia Kovalevskaya

A major mathematician whose work included differential equations and mathematical analysis.



20th Century — Emmy Noether

Made fundamental contributions to abstract algebra and mathematical physics.



20th Century — Katherine Johnson

Used mathematics extensively in aerospace research and orbital calculations.



21st Century — Maryam Mirzakhani

The first woman to receive the Fields Medal, for her influential work in geometry and dynamical systems.

A Continuing Journey

The history of women in mathematics is not merely a collection of biographies. It is a story of perseverance, discovery and the gradual expansion of opportunities for women in education and research.

❖ Hypatia of Alexandria



350–415 CE

Hypatia of Alexandria was a philosopher, mathematician and astronomer who lived in Alexandria, a major centre of learning in the ancient world.

She is one of the earliest women associated with mathematics whose life and intellectual work are documented in historical sources.

Hypatia taught mathematics, astronomy and philosophy. She was associated with the intellectual tradition of the Alexandrian school and was respected as a teacher and scholar.

Her Importance

Hypatia represents the participation of women in intellectual life during a period when formal educational opportunities for women were extremely limited.

Her life has become a symbol of the pursuit of knowledge and learning.

Did You Know?

Hypatia is often remembered as one of the earliest well-known women in the history of mathematics.

Key Areas: Mathematics • Astronomy • Philosophy

Ada Lovelace

1815–1852



Ada Lovelace was an English mathematician and writer who is widely regarded as a pioneer of computer programming.

She worked on the ideas surrounding Charles Babbage's proposed **Analytical Engine**, an early design for a general-purpose mechanical computer.

Lovelace wrote extensive notes about the Analytical Engine. Among these notes was an algorithm intended for the machine to process Bernoulli numbers. For this reason, she is often described as the world's first computer programmer.

Mathematics and Computing

Ada Lovelace's work is particularly interesting because it demonstrates the connection between mathematics and computing.

Modern computers perform calculations and manipulate information according to algorithms. Lovelace recognized that a calculating machine could potentially work with more than just numbers and could follow a sequence of operations.

Legacy

Today, Ada Lovelace is remembered as an important historical figure in mathematics, computing and the history of programming.

Key Areas: Mathematics • Algorithms • Computing

❖ Emmy Noether

1882–1935



Emmy Noether was a German mathematician whose work had a profound influence on modern mathematics and mathematical physics.

She made fundamental contributions to abstract algebra, particularly the study of rings, ideals and related **algebraic structures**.

Her mathematical ideas also had an important influence on theoretical physics.

Noether's Theorem

One of Noether's most famous achievements is Noether's theorem, which establishes a deep connection between continuous symmetries and conservation laws in physics.

For example:

Time-translation symmetry → Conservation of energy

This connection is one of the important ideas underlying modern theoretical physics.

Why is Emmy Noether important?

Noether transformed the way mathematicians understood algebraic structures. Her work continues to influence algebra, geometry and physics.

Her story also illustrates how a mathematician can have an enormous impact even when working with highly abstract ideas.

Key Areas: Abstract Algebra • Mathematical Physics

❖ **Katherine Johnson**

1918–2020



Katherine Johnson was an American mathematician whose calculations played an important role in the early American space programme.

She worked for NASA and became known for her exceptional accuracy in mathematical calculations involving flight trajectories and orbital mechanics.

Her work helped engineers and astronauts understand the paths of spacecraft.

Mathematics and Space Exploration

Space travel requires precise mathematical calculations. The position and motion of a spacecraft can be described using mathematics, physics and differential equations.

Johnson's mathematical work contributed to the success of important space missions.

Her Legacy

Katherine Johnson became an inspiration for students interested in mathematics, science and engineering. Her life demonstrates how mathematical knowledge can have a direct impact on major technological achievements.

Key Areas: Applied Mathematics • Orbital Mechanics • Space Science

❖ Maryam Mirzakhani

1977–2017



Maryam Mirzakhani was an Iranian-American mathematician whose research focused mainly on geometry and dynamical systems.

In **2014**, she became **the first woman to receive the Fields Medal**, one of the highest honours in mathematics.

Her Research

Mirzakhani worked on challenging problems involving:

- Riemann surfaces
- Moduli spaces
- Hyperbolic geometry
- Dynamical systems

Her work connected different areas of mathematics and opened new directions for research.

A Historic Achievement

The Fields Medal is awarded by the International Mathematical Union and is widely regarded as one of the most prestigious honours in mathematics.

Mirzakhani's achievement was historic because she became the first woman to receive the award.

Her Inspiration

Mirzakhani's work showed that mathematics can be approached with imagination and creativity. She often emphasized the importance of persistence when working on difficult mathematical problems.

Her achievements continue to inspire young mathematicians around the world.

Key Areas: Geometry • Dynamical Systems • Riemann Surfaces

▪ **Indian Women in Mathematics**

India has a long mathematical tradition, and Indian women have also contributed to modern mathematical research.

Raman Parimala

Raman Parimala is an Indian mathematician known for her work in algebra, particularly in areas related to quadratic forms and algebraic groups.

She has received international recognition for her mathematical research and has contributed significantly to the development of modern algebra.

Sujatha Ramdorai

Sujatha Ramdorai is an Indian mathematician whose research includes number theory and arithmetic geometry.

She has received several honours for her contributions to mathematics and has played an important role in mathematical research and education.

Inspiring the Next Generation

The achievements of Indian women mathematicians show that students in India can contribute to mathematics at an international level.

Their work provides encouragement to young students who wish to pursue mathematics as a subject, research field or career.

➤ **Challenges Faced by Women**

The history of women in mathematics includes many challenges. In different periods and societies, women faced barriers such as limited access to education, restricted academic opportunities and social expectations.

Some women mathematicians had to work harder to gain recognition for their research.

However, the situation has changed significantly over time. Women today participate in universities, research institutions and technology industries across the world.

Women in Mathematics Today

Women mathematicians currently work in many areas, including:

Pure Mathematics

- Algebra
- Number Theory
- Geometry
- Analysis

Applied Mathematics

- Mathematical Modelling
- Statistics
- Mathematical Biology
- Operations Research

Modern Technology

- Computer Science
- Cryptography
- Data Science
- Artificial Intelligence
- Machine Learning

Looking Ahead

The future of mathematics depends on encouraging talented students from all backgrounds to explore the subject.

Creating equal opportunities in education and research can help mathematics benefit from a wider range of ideas, perspectives and approaches.

➤ Mathematical Fun Corner

Puzzle 1 — Fibonacci Sequence

Complete the sequence:

1, 1, 2, 3, 5, 8, 13, __, __, __

Answer: 21, 34, 55

Puzzle 2 — Think Mathematically

I am an odd number.

Take away one letter and I become even.

What am I?

Answer: Seven

(Removing the letter “s” gives “even”.)

Interesting Mathematical Facts

1. π is an irrational number.
2. Zero is neither positive nor negative.
3. The Fibonacci sequence appears in many mathematical models and is

associated with patterns observed in nature.

4. Mathematics is fundamental to modern computing and cryptography.

5. Maryam Mirzakhani was the first woman to receive the Fields Medal.

Quote Corner

“Mathematics is not only about numbers; it is about patterns, structures and ideas.”

Think • Explore • Calculate • Discover

❖ Conclusion

The story of women in mathematics is a story of courage, creativity, perseverance and discovery.

From Hypatia's intellectual work in ancient Alexandria to Ada Lovelace's ideas about computing, Emmy Noether's contributions to modern algebra and mathematical physics, Katherine Johnson's applications of mathematics to space exploration, and Maryam Mirzakhani's groundbreaking work in geometry, women have played an important role in the development of mathematics.

Their achievements remind us that mathematics is not defined by gender. It is a universal discipline built on curiosity, logic, imagination and creativity.

As students of mathematics, we can learn not only from the mathematical achievements of these women but also from their determination to continue learning despite difficulties.

The journey of women in mathematics continues, and the future may be shaped by the ideas of the next generation of mathematicians.

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