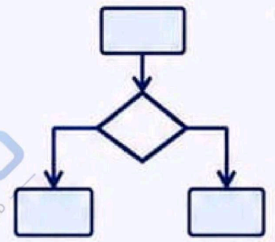
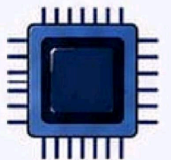


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Infographics



Visual Learning

Better understanding through visual content.



Simplified Concepts

Complex topics explained in simple and visual form.



Quick Revision

Easy to revise important points and diagrams.

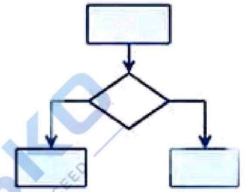


Exam Ready

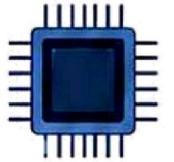
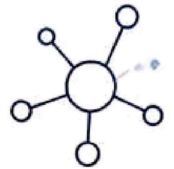
Helps in faster revision and better exam preparation.



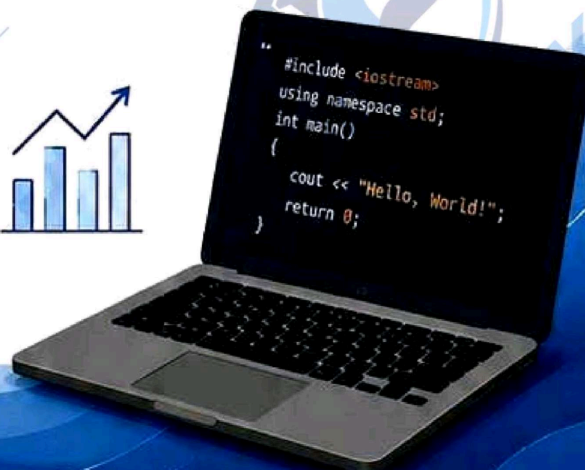
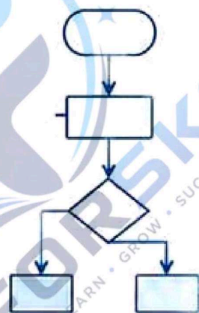
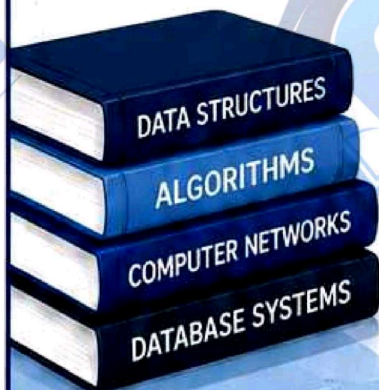
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Unit - III



NUMBER SYSTEM IN INDIA - HISTORICAL EVIDENCE

India gave the world not just numbers, but a complete system of thought.

INDIA - THE BIRTHPLACE OF OUR NUMBERS

- The decimal place value system and the symbol for ZERO (0) were developed in India.
- Indian mathematicians created a logical, positional system that made calculations simple and powerful.
- This innovation changed mathematics forever and became the foundation of modern arithmetic, algebra and computer science.

EVOLUTION OF INDIAN NUMERALS

From Symbols to Our Modern Digits

Brahmi (3rd century BCE)	𑀓 𑀔 𑀕 𑀖 𑀗 𑀘 𑀙 𑀚
Gupta (4th-6th century CE)	𑀧 𑀨 𑀩 𑀪 𑀫 𑀬 𑀭 𑀮
Siddham (7th-9th century CE)	𑀧 𑀨 𑀩 𑀪 𑀫 𑀬 𑀭 𑀮
Devanagari (10th century CE)	१ २ ३ ४ ५ ६ ७ ८ ९
Modern Digits (Used Worldwide)	1 2 3 4 5 6 7 8 9 0

THE SPECIAL GIFT OF INDIA - ZERO

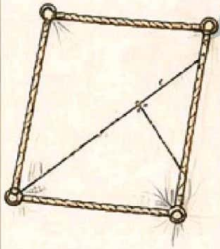
- Zero is not just a number, it is a concept.
- First clear use of ZERO as a number and as a placeholder in positional notation is found in India.
- It made it possible to represent large numbers and perform complex calculations.
- The world adopted zero through Indian-Arab transmission.

०
शून्य
(ZERO)

HISTORICAL EVIDENCE FROM ANCIENT INDIAN SOURCES

1. SULBA SUTRAS (800-200 BCE)

Early geometrical texts used for altar construction. Evidence of understanding of integers, fractions, square roots and Pythagorean triples.



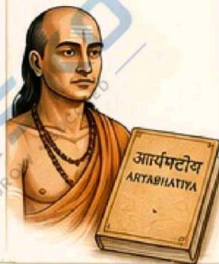
2. BAKSHALI MANUSCRIPT (3rd - 7th century CE)

One of the earliest manuscripts on mathematics. Contains arithmetic operations, negative numbers, zero and solutions of quadratic equations.



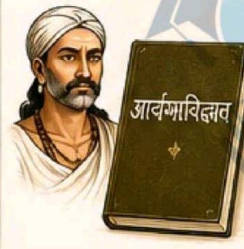
3. ARYABHATIYA (499 CE)

By Aryabhata. Explains place value system, zero, arithmetic operations, and large numbers using the decimal system.



4. BRAHMASPHUTASIDDHANTA (628 CE)

By Brahmagupta. Clear rules for arithmetic with zero and negative numbers. Advanced methods for solving equations.



5. LEELAVATI (12th century CE)

By Bhaskaracharya II. Rich in arithmetic, algebra, geometry and practical problems with systematic methods.



6. INSCRIPTIONS & ARCHAEOLOGICAL EVIDENCE

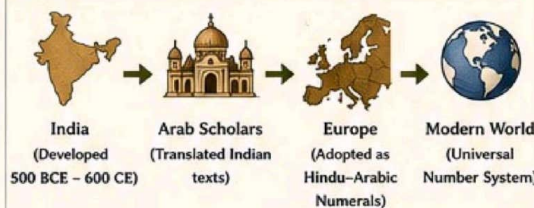
Many temple inscriptions, coins and ancient records contain numbers written in early Indian numeral forms, proving their widespread use.



KEY FEATURES OF THE INDIAN NUMBER SYSTEM

- 10** Decimal System (Base 10)
Uses 10 digits: 0-9
- Place Value System**
The value of a digit depends on its position.
- 0** Zero as a Number & Placeholder
A revolutionary concept unique to India.
- 10ⁿ** Supports Large Numbers
Allows easy representation and calculation of very large and very small numbers.
- Algorithmic Operations**
Simple rules for arithmetic, algebra and beyond.

JOURNEY FROM INDIA TO THE WORLD



"The numerals which are now common everywhere have their origin from India."

- George Ifrah
(Author, The Universal History of Numbers)

IMPACT ON THE WORLD

- Made mathematics universal and easy to learn.
- Enabled science, engineering, astronomy and technology.
- Became the backbone of modern computing and digital world.
- Empowered trade, finance and daily life calculations.
- One of India's greatest contributions to humanity.

EXAMPLES SHOWING THE POWER OF OUR NUMBER SYSTEM

PLACE VALUE

Number:	2	3	4	5
Thousands				
Hundreds				
Tens				
Ones				
	2000	300	40	5
Total =	2345			

WITHOUT ZERO

Try writing 1005 without zero.
It would be impossible to show that there is 'no tens'.

ZERO makes the system complete and logical.

LARGE NUMBERS

10-digit number:
9,876,543,210
Easy to write, easy to read, easy to calculate!

POWER OF CALCULATION

$$(125 \times 48) + (360 \div 15) - 29$$

$$= 6000 + 24 - 29$$

$$= 5995$$

Efficient because of our positional system.



OUR HERITAGE, OUR PRIDE

The number system in India is not just a mathematical invention, it is a timeless intellectual legacy that continues to power the modern world.



From ancient wisdom to modern innovation - Indian numbers lead the way.

यत्र संख्याः, तत्र सिद्धिः ।
Where there are numbers, there is achievement.

India counted the world into the future.

SALIENT FEATURES OF THE INDIAN NUMERAL

India's Gift to the World – A System that Counts Beyond Numbers

From ancient wisdom to global legacy –
The Indian numeral system is the foundation of modern mathematics.

1. DECIMAL (BASE-10) SYSTEM

India developed a positional decimal system with base 10.

Thousands	Hundreds	Tens	Ones
2	3	4	5

↓ ↓ ↓ ↓
2000 300 40 5

The value of a digit depends on its position.

10

Base

2. USE OF ZERO (0)

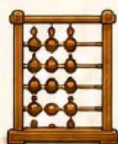
- India is the only ancient civilization to conceptualize Zero as a number.
- Zero acts as a placeholder and enables representation of any large number.

0

शून्य
(Zero)

3. PLACE VALUE SYSTEM

The value of a digit is determined by its place in the number.



Example: 5 2 7 8
↓ ↓ ↓ ↓
5000 + 200 + 70 + 8
= 5,278

4. SYMBOLS FOR ALL DIGITS (0-9)

India developed unique symbols for all ten digits.

0	1	2	3	4	5	6	7	8	9
०	१	२	३	४	५	६	७	८	९

A complete set of digits – simple, logical and efficient.

5. POSITIONAL NOTATION

The same digit has different values at different positions.

Example:
2 2 2
↓ ↓ ↓
Hundreds Tens Ones
200 + 20 + 2 = 222

6. WRITTEN FROM LEFT TO RIGHT

Indian numerals are written from left to right, which is natural and easy to read.

1 2 3 4 5 6 7 8 9

7. COMPACT AND CONCISE

Large numbers can be written in a short and compact form.



Example:

98,76,54,321

(Ten-digit number in just 10 symbols)

8. EASY TO PERFORM ARITHMETIC OPERATIONS

Addition, subtraction, multiplication and division become easier and systematic due to place value and zero.



9. ABILITY TO REPRESENT VERY LARGE AND VERY SMALL NUMBERS



Indian system can represent numbers of any size using the same 10 symbols.

Very Large:

7,89,00,00,00,00,00,000
(septendecillion)



No Limit

Very Small:

0.0000000000000001 (10^{-16})
and beyond...



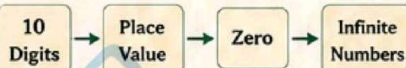
10. UNIVERSAL AND TIMELESS

- Developed in India, adopted all over the world.
- Used in mathematics, science, engineering, commerce, computing and daily life.
- A system that is simple, efficient and future-ready.



11. LOGICAL AND SYSTEMATIC STRUCTURE

Built on a strong logic:

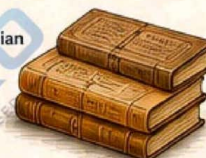


This structure is the backbone of modern mathematics and computing.



12. CULTURAL AND HISTORICAL SIGNIFICANCE

- Described in ancient Indian texts like Sulba Sutras, Aryabhatiya, Brahmasphutasiddhanta, Lilavati.
- A remarkable achievement of Indian mathematicians.
- A proud contribution of India to the world.



EVOLUTION OF INDIAN NUMERALS

Brahmi (3rd century BCE)	Gupta (4th–6th century CE)	Siddham (7th–9th century CE)	Nagari (10th–12th century CE)	Modern Devanagari (13th century CE) onwards	International Form (Used Worldwide)
𑀓 𑀕 𑀇 𑀉 𑀚	१ २ ३ ४ ५	१ २ ३ ४ ५	१ २ ३ ४ ५	० १ २ ३ ४ ५ ६ ७ ८ ९	0 1 2 3 4 5 6 7 8 9

OUR HERITAGE, OUR PRIDE

The Indian numeral system is not just a way of counting, it is a brilliant invention that changed the world forever.

Where there are numbers,
there is order;
where there is order,
there is progress.

INDIAN NUMERALS –

INVENTED IN INDIA, PERFECTED FOR THE WORLD,
POWERING THE FUTURE.

CONCEPT OF ZERO AND ITS IMPORTANCE

A SMALL SYMBOL THAT CHANGED THE WORLD

“Zero is not nothing,
Zero is something that makes everything possible.

The world adopted it,
and humanity
moved from counting
to calculating,
from limits to
infinite possibilities.

1. HISTORICAL ORIGIN

- The concept of Zero was developed in India.
- Earliest use of a symbol for Zero found in Bakhshali Manuscript (3rd–4th century CE).
- Aryabhata (499 CE) used '0' in mathematical calculations.
- Brahmagupta (628 CE) gave rules for Zero in his book *Brahmasphutasiddhanta*.
- From India, Zero traveled to the Arab world, then to Europe, changing the course of mathematics and science.



Bakhshali Manuscript



Aryabhata



Brahmagupta

2. WHAT IS ZERO?

Zero (0) is a number that represents 'no quantity' or 'nothing', but it has a value and a place.



- Not negative
- Not positive
- It is neutral

Zero is neither less nor greater than any number.

3. PROPERTIES OF ZERO

◆ Addition	$a + 0 = a$
◆ Subtraction	$a - 0 = a, \quad 0 - a = -a$
◆ Multiplication	$a \times 0 = 0$
◆ Division	$0 \div a = 0 \quad (a \neq 0)$ $a \div 0 = \text{Undefined}$
◆ Place Value	Zero as a placeholder gives value to other digits.

4. IMPORTANCE OF ZERO

1. FOUNDATION OF MATHEMATICS



Zero made the Decimal Place Value System possible, simplifying calculations.

2. EFFICIENCY IN CALCULATIONS



Makes arithmetic operations easier and more systematic.

3. SCIENCE & TECHNOLOGY



Essential in physics, computer science, engineering and space exploration.

4. MODERN COMPUTING & DIGITAL WORLD



Binary system (0 and 1) powers all digital devices, computers and AI.

5. FINANCE & ECONOMICS



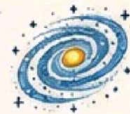
Zero is crucial in banking, accounting, statistics and financial modeling.

6. MEASUREMENT & PRECISION



Enables precision in measurements, instruments and scientific data.

7. ENDLESS POSSIBILITIES



From zero come infinite numbers, shapes, patterns and innovations.

5. EXAMPLES SHOWING THE POWER OF ZERO

PLACE VALUE EXAMPLE

2	0	5
Hundreds	Tens	Ones
↓	↓	↓
200	0	5

Without zero, we cannot represent numbers like 205, 1008, or 10,000 correctly.

LARGE NUMBERS

1,00,00,000 (One Crore)
= 1 followed by 7 zeros

1 0 0 0 0 0 0

Zero allows us to write and understand very large numbers easily.

COMPARISON

Without Zero: 135

With Zero: 105

Zero changes the value and meaning of numbers completely.

MATHEMATICAL EXPRESSION

$$(125 \times 8) + (360 \div 15) - 29$$

$$= 1000 + 24 - 29$$

$$= 1024 - 29$$

$$= 995$$

Zero makes complex calculations possible and accurate.

6. JOURNEY OF ZERO TO THE WORLD



India (Ancient Times)
Concept of Zero developed by Indian mathematicians.



Arab World (7th–9th Century)
Indian numbers and Zero reached Arab scholars.



Europe (12th Century)
Introduced to Europe by Fibonacci.



Modern World
Now Zero is universal, used everywhere in science, technology & daily life.

7. INSPIRING WORDS

“Zero is the greatest discovery of India. It is the basis of all modern mathematics and technology.
– Dr. Radhakrishnan

The introduction of Zero was a turning point in the intellectual history of mankind.
– George Ifrah



8. AMAZING FACTS

- Zero is the only number that is equal to its negative ($0 = -0$).
- Zero is a whole number, natural number and an integer.
- Zero has no Roman numeral – another reason why the Indian system is superior.
- A calculator or computer cannot work without zero!



9. CONCLUSION

Zero is not “nothing”.
It is “something” that gives value, meaning and power to numbers.
It is a symbol of human intelligence, creativity and progress.

From Zero,
Infinite Possibilities!



A SMALL SYMBOL FROM INDIA • A GIANT LEAP FOR HUMANITY

यत्र शून्यम्, तत्र पूर्णम् | – Where there is Zero, there is Infinity.

LARGE NUMBERS AND THEIR REPRESENTATION

From Counting Seeds to Counting the Universe

The Indian number system has no limits. It grows with the imagination and need of humanity.

– Aryabhata

WHY DO WE NEED LARGE NUMBERS?



Astronomy
Distance between stars and galaxies



Population
Counting billions of people



Economics
GDP, national debt, large transactions



Science
Atoms, molecules and beyond



Computing
Data storage, IP addresses, etc.

INDIAN HERITAGE

- Indian mathematicians developed a powerful positional decimal system.
- They used large numbers for astronomy, geometry, commerce and time calculation.
- Texts like Aryabhatiya, Brahmasphutasiddhanta, Lilavati describe very large numbers.

1. THE INDIAN PLACE VALUE SYSTEM (BASE 10)

Crone (10^7)	Ten Lakh (10^6)	Lakh (10^5)	Ten Thousand (10^4)	Thousand (10^3)	Hundred (10^2)	Ten (10^1)	Ons (10^0)
1	2	3	4	5	6	7	8
1,00,00,000	10,00,000	1,00,000	10,000	1,000	100	10	1

India follows the International (Short) Scale with commas placed in groups of 2 digits after the last 3 digits.

Example: 12,34,56,789

Crone Lakh Thousand Ones

2. INDIAN SYSTEM OF NAMING LARGE NUMBERS

Period	Number Name	Abbreviation	Value	In Digits	In Words
ONES	Ones	–	1	1	One
THOUSANDS	Thousand	K	10^3	1,000	One Thousand
LAKHS	Lakh	L	10^5	1,00,000	One Lakh
	Ten Lakh	TL	10^6	10,00,000	Ten Lakh
CRORES	Crone	Cr	10^7	1,00,00,000	One Crone
	Ten Crone	TC	10^8	10,00,00,000	Ten Crone
HIGHER ORDERS	Arab	A	10^9	1,00,00,00,000	One Arab
	Kharab	Kh	10^{11}	1,00,00,00,00,000	One Kharab
	Neel	N	10^{13}	1,00,00,00,00,00,000	One Neel
	Padma	P	10^{15}	1,00,00,00,00,00,00,000	One Padma
	Shankh	Sh	10^{17}	1,00,00,00,00,00,00,00,000	One Shankh
	Mahashankh	MSh	10^{19}	1,00,00,00,00,00,00,00,00,000	One Mahashankh

3. EXAMPLES OF LARGE NUMBERS

- 12,34,56,789
Twelve Crone Thirty Four Lakh Fifty Six Thousand Seven Hundred Eighty Nine
- 9,87,65,43,210
Nine Hundred Eighty Seven Crone Sixty Five Lakh Forty Three Thousand Two Hundred Ten
- 1,00,00,00,00,000,000
One Neel
- 7,89,00,00,00,00,00,00,000
Seven Padma Eighty Nine Shankh

Indian system can represent extremely large numbers with clarity and logic.

4. SCIENTIFIC (EXPONENTIAL) NOTATION

Very large numbers are often written in powers of 10.

General form: $N = a \times 10^n$ where $1 \leq a < 10$

Examples:

- $6,02,000,000 = 6.02 \times 10^8$
- $9,460,730,000,000 = 9.46073 \times 10^{12}$
- $1,00,00,00,00,00,000 = 1 \times 10^{14}$
- $3,00,00,00,00,00,00,00,000 = 3 \times 10^{18}$



5. COMPARING LARGE NUMBERS

Compare the number of digits. If equal, compare from left to right.

Compare: 98,76,54,321 and 1,02,34,567

Both have 8 digits. Compare from left.

Since $9 > 1$, $98,76,54,321 > 1,02,34,567$

Compare: 1,23,45,67,890 and 1,23,45,67,899

Both have 10 digits. Compare from left.

Last digit $0 < 9$, $1,23,45,67,890 < 1,23,45,67,899$

DID YOU KNOW?

The number of atoms in a grain of sand is about 10^{18} .

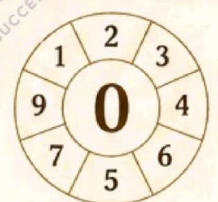
The number of stars in the observable universe is about 10^{22} to 10^{24} !

6. REAL LIFE REPRESENTATION OF LARGE NUMBERS

World Population (approx.)	8,000,000,000 (8 billion)
Distance from Earth to Sun	149,600,000 km (1.496×10^8 km)
Number of Cells in Human Body	37,200,000,000,000 (3.72×10^{13})
GDP of India (2023–24)	3,55,00,00,00,00,000 (3.55×10^{13} INR)
Age of Universe (approx.)	13,80,00,00,00,000,000 years (1.38×10^{10} years)

7. KEY FEATURES OF INDIAN NUMBER SYSTEM

- Positional – Value depends on the position of digit.
- Decimal – Based on 10 symbols (0–9).
- Efficient – Easy to write, read and calculate.
- Scalable – Can represent infinitely large numbers.
- Universal – Adopted and respected worldwide.



KEY TAKEAWAY

Large numbers help us understand the vastness of the world and beyond. The Indian numeral system gives us a powerful way to represent, compute and explore infinite possibilities.

गणितं विज्ञानानाम् मूलम् ।

Mathematics is the root of all sciences.

"From the smallest unit to the largest cosmos, numbers connect everything. The Indian mind saw no limits in numbers."

– Brahmagupta

PLACE VALUE OF NUMERALS

The Position that Gives Value to a Digit

Indian mathematicians developed the place value system, the foundation of modern mathematics.

WHAT IS PLACE VALUE?

In our number system, the value of a digit depends on its position (or place) in a number.

The same digit can have different values at different places.

EXAMPLE

The digit 7 in **2 7 4 6**

Thousands Place	Hundreds Place	Tens Place	Ones Place
= 7,000	= 700	= 70	= 7

THE INDIAN PLACE VALUE SYSTEM (BASE 10)

HIGHER ORDERS				LOWER ORDERS				
Ten Crore	Crore	Ten Lakh	Lakh	Ten Thousand	Thousand	Hundred	Ten	One
10^8	10^7	10^6	10^5	10^4	10^3	10^2	10^1	10^0
00,00,00,000	0,00,00,000	00,00,000	0,00,000	00,000	0,000	000	00	0
Crores		Lakhs		Thousands		Ones		

KEY POINTS

- ✓ We use 10 digits: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9.
- ✓ Each place is 10 times the value of the place to its right.
- ✓ When we move one place to the left, we multiply by 10.
- ✓ When we move one place to the right, we divide by 10.

Place value makes our number system concise, efficient and powerful.

VALUE OF DIGITS AT DIFFERENT PLACES

EXAMPLE 1

Consider the number: **6 8 7 2**

Digit	Place	Place Value	Expanded Form
6	Ten Thousands	$6 \times 10^4 = 60,000$	60,000 +
3	Thousands	$3 \times 10^3 = 3,000$	3,000 +
8	Hundreds	$8 \times 10^2 = 800$	800 +
7	Tens	$7 \times 10^1 = 70$	70 +
2	Ones	$2 \times 10^0 = 2$	2

Therefore, $63,872 = 60,000 + 3,000 + 800 + 70 + 2$



Same digit,
Different place,
Different value.

EXAMPLE 2

Consider the number: **4 0 5 0 9**

Digit	Place	Place Value	Expanded Form
4	Ten Thousands	$4 \times 10^4 = 40,000$	40,000 +
0	Thousands	$0 \times 10^3 = 0$	0 +
5	Hundreds	$5 \times 10^2 = 500$	500 +
0	Tens	$0 \times 10^1 = 0$	0 +
9	Ones	$9 \times 10^0 = 9$	9

Therefore, $40,509 = 40,000 + 0 + 500 + 0 + 9$

EXAMPLE 3: SAME DIGIT, DIFFERENT PLACES

Let's see the digit 5 in different numbers.

- 5 in 5 = $5 \times 10^0 = 5$
- 5 in 50 = $5 \times 10^1 = 50$
- 5 in 500 = $5 \times 10^2 = 500$
- 5 in 5,000 = $5 \times 10^3 = 5,000$
- 5 in 50,000 = $5 \times 10^4 = 50,000$

The value of 5 changes with its place (position).

EXAMPLE 4: PLACE VALUE IN INDIAN SYSTEM

Consider the number: **7,89,65,432**

Crore	Lakh	Thousand	Ones
7	89	65	432

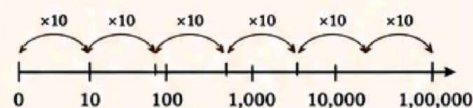
Expanded Form:

$7,89,65,432 =$

$7 \times 1,00,00,000 + 89 \times 1,00,000 +$
 $65 \times 1,000 + 432$

$= 7,00,00,000 + 89,00,000 + 65,000 + 432$

EXAMPLE 5: PLACE VALUE ON NUMBER LINE



Each step to the left is 10 times bigger.
Each step to the right is 10 times smaller.

This is the power of place value!

IMPORTANCE OF PLACE VALUE

- ✓ It allows us to represent any large number using only 10 digits.
- ✓ It makes reading, writing and comparing numbers easy.
- ✓ It is essential for arithmetic operations.
- ✓ It is the foundation of our decimal number system and modern computing.

INTERESTING FACTS

- ★ The Indian place value system was one of the greatest contributions of India to the world.
- ★ It includes the concept of Zero (0), which acts as a placeholder.
- ★ Arab scholars learned this system from India and introduced it to the world.

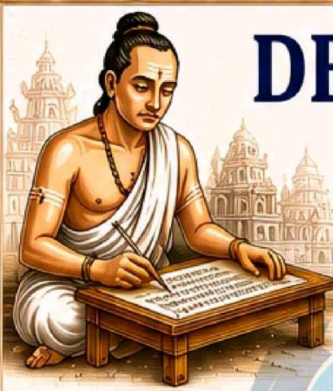
QUICK RECAP

- ▶ Value depends on Place.
- ▶ Right → Smaller ($\div 10$)
- ▶ Left → Bigger ($\times 10$)
- ▶ Position gives Power to a Digit!

Where there is number, there is order;
where there is order, there is progress.

यत्र संख्या, तत्र सिद्धिः ।
(Where there are numbers, there is achievement.)

THE INDIAN PLACE VALUE SYSTEM - A TIMELESS GIFT TO HUMANITY



DECIMAL NUMBER SYSTEM

A SYSTEM BASED ON 10 – SIMPLE, POWERFUL AND UNIVERSAL

The decimal system is a number system in which numbers are represented using the digits 0 to 9 and each place value is a power of 10.

"Our Rishis gave the world the concept of Zero and the Decimal System."
– Aryabhata

THE GIFT OF INDIA TO THE WORLD

The concept of Zero (0) and the Decimal System were developed in ancient India.



1. WHAT IS THE DECIMAL NUMBER SYSTEM?

- It is a positional number system with base (or radix) 10.
- It uses ten digits: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9.
- The value of a digit depends on its position (place).
- Each place to the left is 10 times greater.
- Each place to the right is 10 times smaller.

2. THE TEN DIGITS

0	1	2	3	4
5	6	7	8	9

These ten digits are enough to represent any number, big or small!

3. PLACE VALUE CHART

Higher Orders		Whole Number Part		Decimal (Fractional) Part			Lower Orders	
Thousands	Hundreds	Tens	Ones	Tenths	Hundredths	Thousandths	Ten Thousandths	...
10^3	10^2	10^1	10^0	10^{-1}	10^{-2}	10^{-3}	10^{-4}	...
Example:	2	3	5	.	6	4	7	9
	2,000	300	50	.	0.6	0.04	0.007	0.0009

4. PLACE VALUE OF A NUMBER – EXAMPLE

Consider the number: **4 2 7 . 3 8 6**

Digit	Place	Place Value	Expanded Form
4	Hundreds	4×10^2	400
2	Tens	2×10^1	20
7	Ones	7×10^0	7
.	Decimal Point	–	–
3	Tenths	3×10^{-1}	0.3
8	Hundredths	8×10^{-2}	0.08
6	Thousandths	6×10^{-3}	0.006

Expanded Form: $400 + 20 + 7 + 0.3 + 0.08 + 0.006 = 427.386$

5. SALIENT FEATURES

10

It is a base-10 system.

0-9

It uses only ten digits (0 to 9).

Positional System

The value of a digit depends on its position.

$10 \times$

Each place to the left is 10 times greater.

$\frac{1}{10}$

Each place to the right is $\frac{1}{10}$ (or 10 times) smaller.

∞

It can represent very large as well as very small numbers.

6. EXAMPLES OF DECIMAL NUMBERS

- Whole Numbers: 0, 1, 25, 623, 10,000
- Decimal Numbers: 3.5, 0.25, 12.75, 98.006
- Very Small Numbers: 0.001, 0.0005
- Very Large Numbers: 1,234,567.89, 7,890,123,456.789



From counting grains to measuring the universe – the decimal system makes it possible!

7. CONVERSION USING PLACE VALUE

Example 1: Write 5,806.724 in expanded form

$$5,806.724 = 5 \times 10^3 + 8 \times 10^2 + 0 \times 10^1 + 6 \times 10^0 + 7 \times 10^{-1} + 2 \times 10^{-2} + 4 \times 10^{-3}$$

$$= 5,000 + 800 + 0 + 6 + 0.7 + 0.02 + 0.004$$

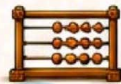
$$= 5,806.724$$

Example 2: Write in standard form

$$3 \times 10^4 + 6 \times 10^2 + 2 \times 10^1 + 5 \times 10^{-1} + 3 \times 10^{-3}$$

$$= 30,000 + 600 + 20 + 0.5 + 0.003$$

$$= 30,620.503$$



8. COMPARING DECIMAL NUMBERS

Compare: 72.45 and 72.405

Step 1: Equal number of decimal places

$$72.45 = 72.450$$

$$72.450 > 72.405$$

$\therefore$ 72.45 is greater than 72.405

Compare: 0.056 and 0.06

$$0.056 < 0.060$$

$\therefore$ 0.056 is smaller than 0.06



9. REAL-LIFE APPLICATIONS

- Money: ₹25.50, ₹100.75
- Measurement: 5.25 m, 0.75 kg
- Temperature: 36.6°C
- Science: 9.8 m/s² (acceleration due to gravity)
- Engineering: 0.005 mm precision
- Computers: Data storage, calculations



The decimal system is the language of science, technology and daily life.

10. ADVANTAGES OF THE DECIMAL SYSTEM

- Easy to understand and use.
- Simplifies arithmetic operations.
- Flexible for expressing fractions and large numbers.
- Essential for mathematics, commerce, science and technology.
- Universal acceptance.



11. A HISTORICAL GLORY

- The decimal system, along with Zero, was developed in India.
- Indian mathematicians like Aryabhata, Brahmagupta and Bhaskara made it powerful.
- It was later adopted by the Arab world and then by the entire globe.



12. INTERESTING FACTS

- There are infinite numbers in the decimal system.
- Between any two decimal numbers, there are infinite decimal numbers.
- The decimal system is the foundation of modern computing.



JOURNEY OF THE DECIMAL SYSTEM

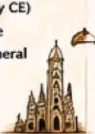
Ancient India
(2000 BCE – 5th Century CE)
Development of place value system and concept of Zero.



Arab Mathematicians
(7th – 10th Century CE)
Spread the decimal system across the world.



Europe
(12th – 16th Century CE)
Adopted as the Hindu-Arabic numeral system.



Modern World
(17th Century onwards)
Universal use in science, commerce, technology and daily life.



SUMMARY

The Decimal Number System is a positional system with base 10 using digits 0–9. It is simple yet powerful, making it the most widely used number system in the world today.

A small idea that changed the world – Zero and Decimal!



"Where there are numbers, there is order; where there is order, there is progress."

APPROACHES TO REPRESENT NUMBERS

Numbers Can Be Represented in Many Ways

Different representations help us understand, compute and apply numbers efficiently in various fields.

The diversity of number representations is the foundation of mathematics, science and technology.

– Ancient Indian Wisdom

WHY MULTIPLE REPRESENTATIONS?

EXAMPLE NUMBER

345

Let's see how this number can be represented in different ways.



MAJOR APPROACHES TO REPRESENT NUMBERS

1. POSITIONAL (PLACE VALUE) REPRESENTATION

Hundreds (10 ²)	Tens (10 ¹)	Ones (10 ⁰)
3	4	5
↓	↓	↓
300	40	5

$$3 \times 10^2 + 4 \times 10^1 + 5 \times 10^0 = 345$$

- Most common system (Base 10).
- Value depends on the position of the digit.
- Used in daily life (counting, money, measurements etc.).

2. EXPANDED FORM

$$300 + 40 + 5$$

$$345 = 300 + 40 + 5$$

- Shows the value of each digit separately.
- Helps in understanding place value.
- Useful in addition, subtraction and teaching.

3. WORD FORM

“Three Hundred Forty Five”

- Numbers written in words.
- Useful in banking, cheques, legal documents and readability.

4. ROMAN NUMERAL REPRESENTATION

CCCLXLV

Symbol	CCC	XL	V
Value	300	40	5
Total	345		

- Uses letters: I, V, X, L, C, D, M.
- Used in ancient times, clocks, book chapters, etc.
- 345 = CCCLXLV

5. BINARY REPRESENTATION (BASE 2)

2 ⁸	2 ⁷	2 ⁶	2 ⁵	2 ⁴	2 ³	2 ²	2 ¹	2 ⁰
256	128	64	32	16	8	4	2	1
1	0	1	0	1	1	0	0	1

$$345_{10} = 101011001_2$$

- Uses only two digits: 0 and 1.
- Fundamental in digital computers & electronics.
- Each position is a power of 2.
- 345 = 256 + 64 + 16 + 8 + 1

6. OCTAL REPRESENTATION (BASE 8)

8 ³	8 ²	8 ¹	8 ⁰
512	64	8	1
5	3	3	1

$$345_{10} = 531_8$$

- Uses digits: 0 to 7.
- Shorter form of binary.
- Used in early computers and digital systems.
- 345 = 5×64 + 3×8 + 1

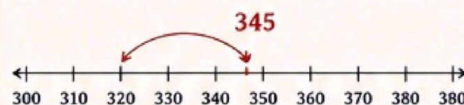
7. HEXADECIMAL REPRESENTATION (BASE 16)

16 ²	16 ¹	16 ⁰
256	16	1
1	5	9

$$345_{10} = 159_{16}$$

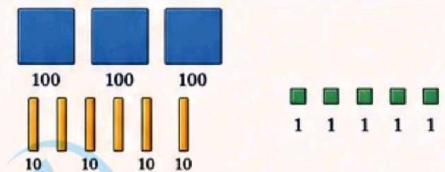
- Uses digits: 0–9 and letters: A–F (10–15).
- Compact and widely used in programming, color codes, memory addresses.
- 345 = 1×256 + 5×16 + 9

8. NUMBER LINE REPRESENTATION



- Shows position of a number on a line.
- Helps in understanding order, comparison, distance and estimation.
- 345 lies between 340 and 350.

9. PICTORIAL / VISUAL REPRESENTATION



$$300 + 40 + 5 = 345$$

- Uses pictures, blocks, dots or objects.
- Best for beginners and visual learners.
- Makes abstract numbers more concrete.

10. FRACTIONS & DECIMAL REPRESENTATION

Fraction Form

$$345 = \frac{345}{1}$$

Decimal Form

$$345 = 345.0$$

- Extends whole numbers to fractions and decimals.
- Essential in real life, science, engineering, finance, etc.

11. SCIENTIFIC NOTATION

$$345 = 3.45 \times 10^2$$

- Expresses numbers as a product of a number between 1 and 10 and a power of 10.
- Used for very large or very small numbers.
- Example:
 $3450000 = 3.45 \times 10^6$
 $0.00345 = 3.45 \times 10^{-3}$



12. COMPUTER & PROGRAMMING REPRESENTATIONS

ASCII (Character Code)
'A' = 65

Unicode
'A' = U+0041

Boolean
True = 1, False = 0

- Computers store and process numbers in various forms for efficiency and functionality.

```
int num = 345;
bin: 101011001
hex: 0x159
oct: 0531
```



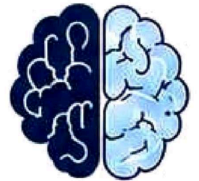
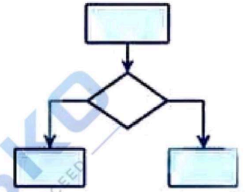
One Number,
Many Representations,
Infinite Possibilities.

Different Approaches – Same Number – Deeper Understanding

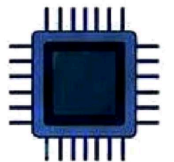
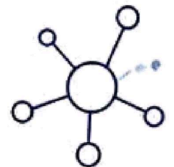
Understanding representations is the key to mastering numbers and solving real-world problems.



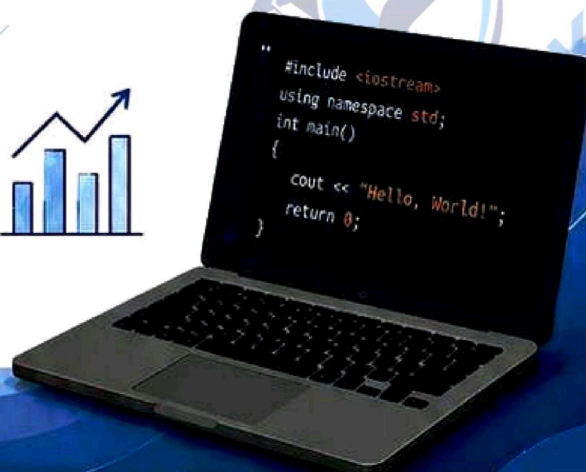
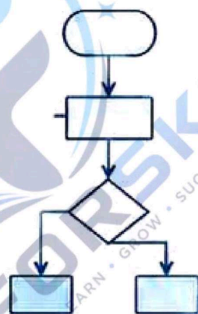
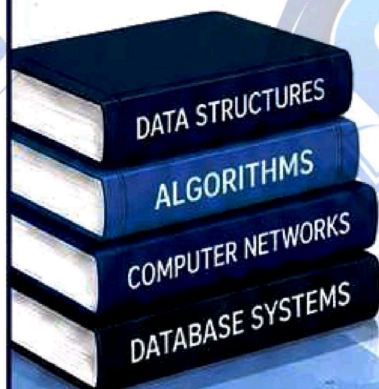
1010101010
0101010101
1010101010
0101010101

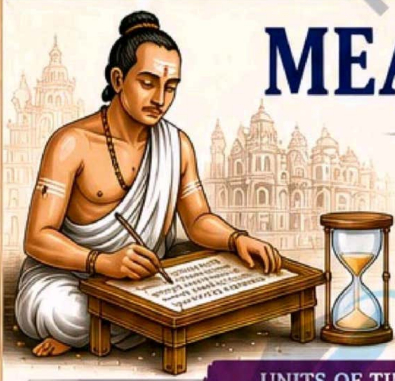


10110
01001
10101



Unit - IV





MEASUREMENTS FOR TIME

→ Measuring Time, Understanding Our World

Time is the most valuable thing a man can spend.
– Theophrastus



From ancient sundials to atomic clocks, humanity has measured time to understand, plan and progress.



UNITS OF TIME – FROM SMALL TO LARGE

Second (s)	Minute (min)	Hour (h)	Day	Week	Month	Year	Decade	Century	Millennium
1 s	60 s	60 min	24 h	7 days	≈ 30 days	365 days (365.25)	10 years	100 years	1,000 years

WHY MEASURE TIME?

- Helps in planning daily activities
- Essential for science, technology and communication
- Needed for navigation, calendars and schedules
- Important in astronomy, history and research

1. BASIC TIME CONVERSIONS

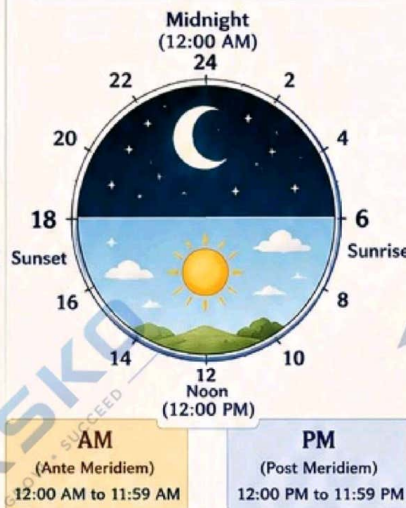
- 1 minute (min) = 60 seconds (s)
- 1 hour (h) = 60 minutes
- 1 day = 24 hours
- 1 week = 7 days
- 1 month ≈ 30 days (28–31 days)
- 1 year = 365 days (365.25 days)
- 1 leap year = 366 days
- 1 decade = 10 years
- 1 century = 100 years
- 1 millennium = 1,000 years



A leap year occurs every 4 years to keep our calendar in sync with the Earth's revolution around the Sun.



2. TIME IN A DAY



3. ANCIENT INDIAN TIME MEASUREMENT

India has a rich tradition of time measurement used in astronomy, rituals and daily life.

Small Units (Traditional)

- 1 Truti ≈ 1/3,750 second
- 1 Lava = 3 Truti
- 1 Nimesha = 16 Lava
- 1 Kshana = 15 Nimesha
- 1 Kala ≈ 30 Kshana
- 1 Muhurta = 2 Kala (≈ 48 minutes)

Larger Units

- 1 Day (Ahoratra) = 30 Muhurta
- 15 Days = 1 Paksha
- 30 Days = 1 Month (Maas)
- 6 Months = 1 Ritu
- 12 Months = 1 Year

These units were used in Panchang (Hindu calendar), Vedic rituals, yoga, astrology and astronomy.



4. ASTRONOMICAL BASIS OF TIME



Rotation of Earth
One rotation on its axis = 1 day (24 hours)



Revolution of Earth
One revolution around the Sun = 1 year (≈ 365.25 days)



Phases of the Moon
Basis for months (Lunar month ≈ 29.53 days)

5. MODERN PRECISE TIME MEASUREMENT



Quartz Clock

Uses crystal vibrations to keep accurate time.
Accuracy: ±15 seconds/month



Atomic Clock

Uses vibrations of atoms (Cesium-133) for timekeeping.
Accuracy: ±1 second in millions of years



GPS Time

Used in navigation, communication and global systems.
Highly accurate and synchronized worldwide.

6. REAL-LIFE APPLICATIONS



Transportation: Train, flight and bus schedules



Communication: Time zones, internet sync



Science: Experiments, research and space missions



Health: Medicine timings, appointments

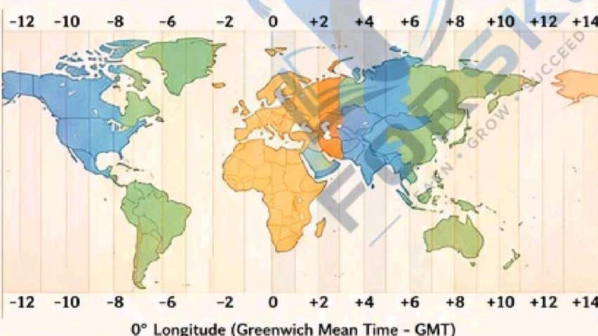


Business: Meetings, deadlines and productivity



Daily Life: Wake up time, study, exercise, rest

7. TIME ZONES OF THE WORLD



Earth is divided into 24 time zones.
Each time zone = 15° of longitude
= 1 hour difference



When it is 12:00 PM (Noon) at GMT (0°), time changes by ±1 hour for every time zone away from GMT.

QUICK FACTS



Light takes 1.255 milliseconds to travel from the Earth to the Moon.



The Universe is about 13.8 billion years old.



The shortest time ever measured is the Planck Time: 5.39×10^{-44} seconds.



Time is not constant – it can change with speed (Einstein's Theory of Relativity).

"Time is what we want most, but what we use worst."
– William Penn



MEASUREMENTS DISTANCE AND WEIGHT

Measurement makes everything precise.
It helps us compare, calculate and understand the world around us.

PART 1: MEASUREMENTS OF DISTANCE (LENGTH)

1. COMMON UNITS OF LENGTH

Unit	Symbol	In Terms of Meter	Example
Kilometer	km	1 km = 1,000 m	Distance between two cities
Meter	m	1 m = 1 m	Height of a door
Centimeter	cm	1 cm = 0.01 m	Length of a pen
Millimeter	mm	1 mm = 0.001 m	Thickness of a coin
Micrometer	μm	1 μm = 0.000001 m	Diameter of a human hair
Nanometer	nm	1 nm = 0.000000001 m	Size of a virus

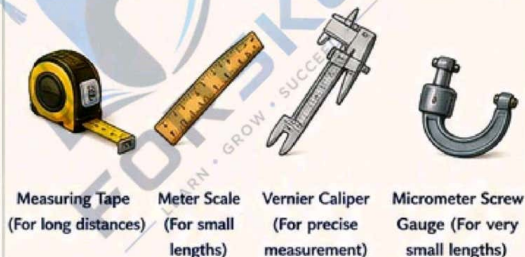
2. CONVERSION OF LENGTH

- 1 km = 1,000 m
- 1 m = 100 cm
- 1 cm = 10 mm
- 1 mm = 1,000 μm
- 1 μm = 1,000 nm

Example:

$$2.5 \text{ km} = 2.5 \times 1,000 \text{ m} = 2,500 \text{ m} = 2,50,000 \text{ cm}$$

3. MEASURING TOOLS



Measuring Tape
(For long distances)

Meter Scale
(For small lengths)

Vernier Caliper
(For precise measurement)

Micrometer Screw Gauge
(For very small lengths)

4. REAL LIFE EXAMPLES



Road length between two cities is measured in kilometers.



Height of a room is measured in meters.

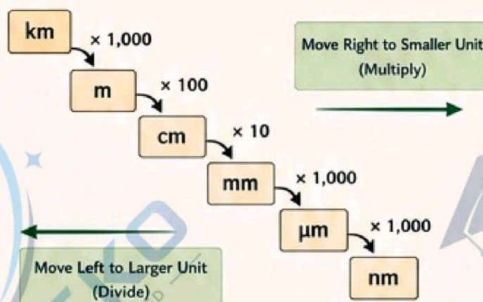


Length of a pencil is measured in centimeters.



Size of bacteria is measured in micrometers or nanometers.

5. RELATION BETWEEN UNITS



6. INTERESTING FACTS – DISTANCE



Circumference of Earth $\approx 40,075 \text{ km}$



Average distance from Earth to Moon $\approx 384,400 \text{ km}$



Distance from Earth to Sun $\approx 150 \text{ million km}$



An atom is about 0.1 nanometer (0.000000001 m) in size!

PART 2: MEASUREMENTS OF WEIGHT (MASS)

1. COMMON UNITS OF WEIGHT (MASS)

Unit	Symbol	In Terms of Kilogram	Example
Tonne (Metric Ton)	t	1 t = 1,000 kg	Weight of a car
Kilogram	kg	1 kg = 1 kg	Weight of a bag of rice
Gram	g	1 g = 0.001 kg	Weight of an apple
Milligram	mg	1 mg = 0.000001 kg	Weight of a medicine tablet

2. CONVERSION OF WEIGHT

- 1 t = 1,000 kg
- 1 kg = 1,000 g
- 1 g = 1,000 mg

Example:

$$3.2 \text{ kg} = 3.2 \times 1,000 \text{ g} = 3,200 \text{ g} = 3,200,000 \text{ mg}$$



3. MEASURING TOOLS



Electronic Balance
(For small mass)

Kitchen Scale
(For daily use)

Platform Scale
(For heavy load)

4. REAL LIFE EXAMPLES



Goods in a truck are measured in tonnes.



Sugar, rice, and flour are measured in kilograms.

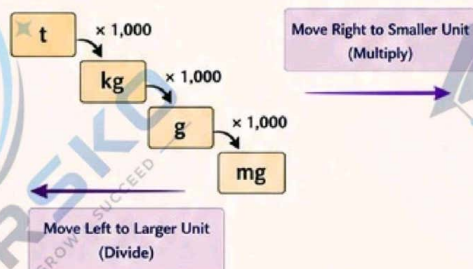


Fruits and vegetables are measured in grams.



Medicines are measured in milligrams.

5. RELATION BETWEEN UNITS



6. INTERESTING FACTS – WEIGHT



Mass of Earth $\approx 5.97 \times 10^{24} \text{ kg}$



1 liter of water has a mass of about 1 kilogram.



A 1 rupee coin weighs about 3.85 grams.



A typical tablet medicine weighs about 500 milligrams.

KEY POINTS

- Distance tells us how far an object is.
- Weight (mass) tells us how much matter an object contains.
- Different units are used for different needs.
- Standard units make communication and calculations easy.

STANDARD UNITS (SI)

For Distance (Length)
Meter (m)

For Weight (Mass)
Kilogram (kg)

REMEMBER

"Measure everything measurable, make everything precise."

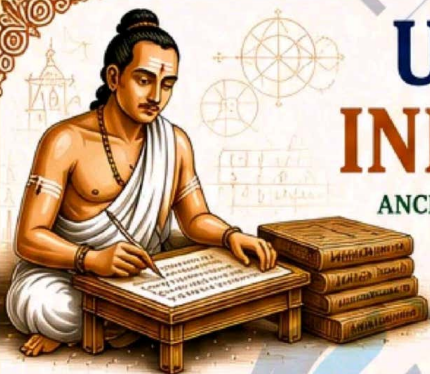


MEASUREMENT IS THE FIRST STEP TOWARDS KNOWLEDGE AND INNOVATION.



UNIQUE ASPECTS OF INDIAN MATHEMATICS

ANCIENT WISDOM • LOGIC • INNOVATION • UNIVERSAL IMPACT

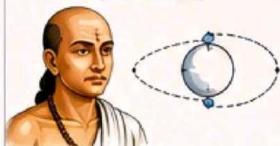


“From the Vedas to the modern world, Indian Mathematics has been a source of timeless knowledge and global inspiration.”



GREAT INDIAN MATHEMATICIANS AND THEIR CONTRIBUTIONS

ĀRYABHATA
(476–550 CE)



Author of *Āryabhaṭīya*.
Introduced place value system and the concept of Zero.

BRAHMAGUPTA
(598–668 CE)



$$\begin{aligned}a + 0 &= a \\a - 0 &= a \\a \times 0 &= 0\end{aligned}$$

First to give rules for Zero and negative numbers in *Brahmasphuṭasiddhānta*.

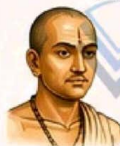
BHĀSKARA II
(1114–1185 CE)



$$\frac{d(y)}{dx}$$

Wrote *Siddhānta Śiromaṇi*.
Worked on calculus ideas, series expansions and advanced equations.

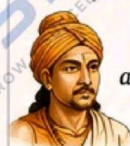
MAHĀVĪRA
(850–910 CE)



$$\begin{array}{c}a-b \\ \swarrow \quad \searrow \\ a \quad \quad b \\ \nwarrow \quad \nearrow \\ d \quad \quad c\end{array}$$

Early work on permutations and combinations in *Gaṇita-sāra-saṅgraha*.

ŚRĪDHARA
(9th Century CE)



$$ax^2 + bx + c = 0$$

Gave method for solving quadratic equations in *Bijagaṇita*.

DISTINCTIVE FEATURES



Holistic Approach: Mathematics was developed along with astronomy, philosophy and practical life.



Abstract Thinking: Development of concepts like Zero, infinity, and large numbers.



Generalization: Formulation of general rules and algorithms.



Systematic Methods: Step-by-step procedures (algorithms) for calculations.



Integration with Real Life: Used in architecture, trade, astronomy, music and rituals.



Strong Logical Foundations: Emphasis on proofs, reasoning and *sūtra* style of expression.

REVOLUTIONARY CONTRIBUTIONS

1. NUMBER SYSTEM

Place value system
(Base 10)



Thousands Hundreds Tens Ones

- Use of Zero as a number and a placeholder.
- Easy representation of large numbers.



The concept of Zero (*śūnya*) is India's gift to the world!

2. ALGEBRA (BĪJAGAṆITA)

General equations and methods for solving them.

$$ax^2 + bx + c = 0$$

- Rules for operations with positives, negatives and Zero.
- Solutions of linear and quadratic equations.

3. GEOMETRY (ŚULBA SŪTRAS)

Precise geometric constructions for altars, temples and rituals.



- Accurate calculation of areas and lengths.
- Approximation of $\sqrt{2}$ (Baudhāyana's value).

4. TRIGONOMETRY (JYOTIṢA)

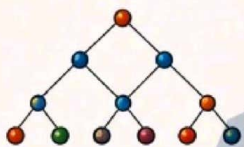
Introduction of trigonometric ratios for astronomical calculations.

$$\sin \theta = \frac{\text{opposite}}{\text{hypotenuse}}$$

- Use of sine tables (*jya* tables).
- Accurate prediction of eclipses and planets.

5. COMBINATORICS

Early study of permutations and combinations.



Number of ways to arrange 3 different objects taken 2 at a time = ${}^3P_2 = 6$

6. INFINITE SERIES

Work on infinite series and convergence.

$$1 + x + x^2 + x^3 + \dots = \frac{1}{1-x} \quad (|x| < 1)$$

- Discussed in works of Bhāskara II.
- Ideas similar to modern calculus.



7. DECIMAL FRACTIONS

Use of decimal fractions and rules for operations.

$$\frac{1}{7} = 0.142857142857 \dots$$

(Repeating decimal)

- Clear rules for arithmetic operations.
- Seen in works of Nīlakaṇṭha Somaayāji.



8. PRACTICAL APPLICATIONS

Indian Mathematics was applied in:

- Astronomy (planetary motions, eclipses, calendars)
- Architecture (temples, town planning, measurements)
- Trade & Commerce (weights, measures, interest calculations)
- Music (rhythmic patterns and combinations)

9. INDIAN MATHEMATICS AND THE WORLD

Indian mathematical ideas spread to the world through Arab scholars.

They translated Sanskrit texts and carried this knowledge to Europe.

This formed the foundation of modern mathematics.



DID YOU KNOW?

- The number system we use today is called the Hindu–Arabic Numeral System.
- Zero, place value, algebra, trigonometry, and combinatorics – all have deep roots in Indian Mathematics.
- Many concepts discovered in India centuries before the modern world!



THE TIMELESS LEGACY

Indian Mathematics is not just a collection of formulas, it is a blend of wisdom, logic, creativity and practicality.



Think (Logically)



Discover (Patterns)



Solve (Problems)



Apply (In Life)



Share (Knowledge)

→ A HERITAGE THAT CONTINUES TO SHAPE OUR FUTURE →

FAMOUS SŪTRA STYLE

Indian mathematicians expressed complex ideas in short, precise *sūtras*.

अल्पाक्षरं असंदिग्धं सारवदं विश्वतोमुखम् ।
अस्त्येवै ज्ञापयिमानं च सूत्रं सूत्रविदो विदुः ॥

(A good *sūtra* is short, unambiguous, essential, universal and pleasing.)

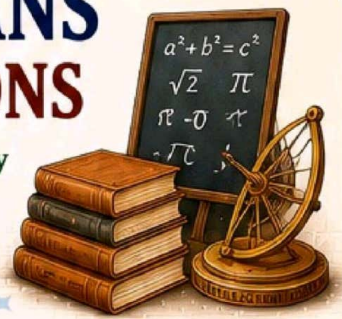
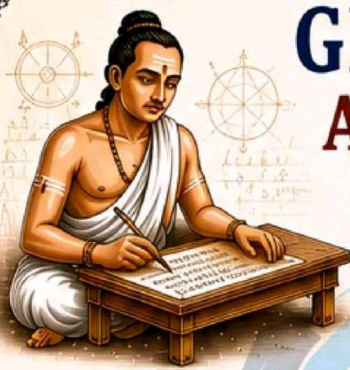


“India gave the world the science of numbers; let us value, learn and carry it forward.”

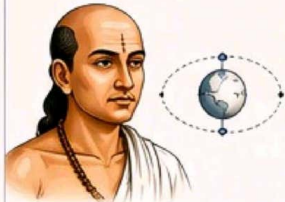
GREAT MATHEMATICIANS AND THEIR CONTRIBUTIONS

Brilliant Minds • Timeless Contributions • Eternal Legacy

“ Indian mathematicians have given the world ideas that are as infinite as numbers themselves. ”



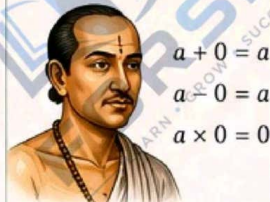
1 ĀRYABHATA (476 – 550 CE)



Key Contributions

- Introduced the concept of Zero.
- Developed place value system.
- Calculated value of π (3.1416 approx).
- Explained Earth's rotation on its axis.
- Wrote Āryabhaṭīya.

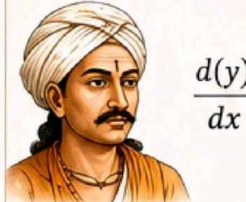
2 BRAHMA GUPTA (598 – 668 CE)



Key Contributions

- Gave rules for arithmetic with Zero.
- Introduced negative numbers.
- Solved linear and quadratic equations.
- Wrote Brahmasphuṭasiddhānta.

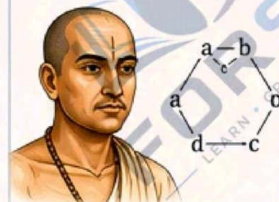
3 BHĀSKARA II (1114 – 1185 CE)



Key Contributions

- Worked on calculus (derivatives).
- Solved complex algebraic equations.
- Explained cyclic nature of the universe.
- Wrote Siddhānta Śiromaṇi.

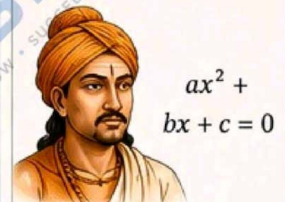
4 MAHĀVĪRA (850 – 910 CE)



Key Contributions

- Early work on permutations and combinations.
- Developed methods for mathematical reasoning.
- Wrote Gaṇita-sāra-saṅgraha.

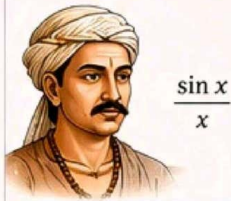
5 ŚRĪDHARA (9th Century CE)



Key Contributions

- Gave general method for solving quadratic equations.
- His work Bijagaṇita is a foundation of algebra.
- Used symbolic methods effectively.

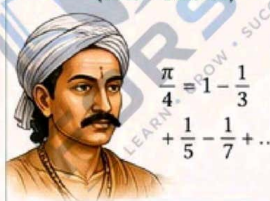
6 NĪLAKAṆṬHA SOMAYAJĪ (1444 – 1544 CE)



Key Contributions

- Developed infinite series for trigonometric functions.
- Accurately calculated π and astronomical values.
- Wrote Tantrasaṅgraha.

7 MADHAVA OF SAṄGAMA GRĀMA (1340 – 1425 CE)



Key Contributions

- Founder of Kerala School of Mathematics.
- Discovered infinite series for π , $\sin x$, $\cos x$, $\arctan x$.
- Pioneered early calculus ideas.

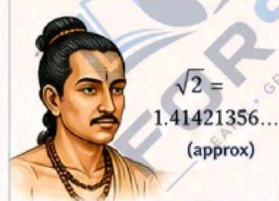
8 VARĀHAMĪHIRA (505 – 587 CE)



Key Contributions

- Wrote Pañca-siddhāntikā on astronomy and mathematics.
- Improved calculation of eclipses and planetary positions.
- Bridged mathematics and astronomy.

9 JYEṢṬHADEVĀ (11th Century CE)



Key Contributions

- Calculated $\sqrt{2}$ correct up to 11 decimal places.
- His accuracy was unmatched for his time.
- Example of deep numerical understanding.

10 S. RAMANUJAN (1887 – 1920 CE)



Key Contributions

- Made extraordinary contributions to number theory, infinite series, continued fractions.
- Introduced many mathematical formulas and identities.
- His work continues to inspire modern mathematics.

COLLECTIVE IMPACT OF INDIAN MATHEMATICIANS

0 Introduced Zero and the Decimal System	Developed Algebra and Equations $ax^2 + bx + c = 0$	Advanced Trigonometry and Calculus	Discovered Infinite Series and Approximations $1 - \frac{1}{3} + \frac{1}{5} - \dots$	Linked Mathematics with Astronomy and Practical Life	Built the Foundation for Modern Mathematics
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DID YOU KNOW?

- The concept of Zero was born in India.
- Indian mathematicians calculated π correct to several decimal places centuries ago.
- Many ideas of calculus came from India long before Newton and Leibniz.
- The Kerala School was doing advanced mathematics in the 14th century.

A TIMELESS LEGACY

From ancient sages to modern geniuses, Indian mathematicians have shown that mathematics is not just numbers—it is creativity, logic and a way of life.

INSPIRATION FOR TOMORROW

Their curiosity, hard work and deep thinking continue to guide us.

Let us learn, explore and contribute to the beautiful world of mathematics.

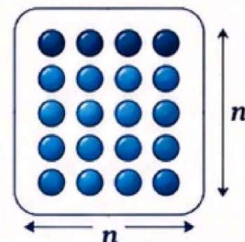
“The glory of mathematics is that it is the most ancient of sciences and yet the most modern.” — G.H. Hardy



ARITHMETIC -

SQUARE OF NUMBER

The square of a number is the product of the number with itself.



1. DEFINITION

The square of a number n is written as n^2 and is calculated as:

$$n^2 = n \times n$$

Example:

$$5^2 = 5 \times 5 = 25$$

2. SQUARES OF NUMBERS (1 TO 20)

n	n^2	n	n^2	n	n^2
1	1	8	64	15	225
2	4	9	81	16	256
3	9	10	100	17	289
4	16	11	121	18	324
5	25	12	144	19	361
6	36	13	169	20	400
7	49	14	196		

3. PROPERTIES



Square of Positive Number is Positive.

$$(+n)^2 = n^2$$



Square of Negative Number is Positive.

$$(-n)^2 = n^2$$



Square of 1 is 1.

$$1^2 = 1$$



Square of 0 is 0.

$$0^2 = 0$$



Square of a Number depends only on its magnitude, not on its sign.

4. PATTERNS IN SQUARES



Even Numbers Pattern

$2^2 = 1$	(Ends with 4)
$4^2 = 16$	(Ends with 6)
$6^2 = 36$	(Ends with 6)
$8^2 = 64$	(Ends with 4)
$10^2 = 100$	(Ends with 00)
$12^2 = 144$	(Ends with 44)

The unit digit of even squares circles: 4, 6, 6, 4, 0, 4, 6, 6, 4, 0...



Odd Numbers Pattern

$1^2 = 1$	(Ends with 1)
$3^2 = 9$	(Ends with 9)
$5^2 = 25$	(Ends with 5)
$7^2 = 49$	(Ends with 9)
$9^2 = 81$	(Ends with 1)
$11^2 = 121$	(Ends with 1)

The unit digit of odd squares circles: 1, 9, 5, 9, 1, 1, 9, 5, 9, 1...

Consecutive Odd Numbers Rule

The difference between the squares of consecutive numbers is an odd number.

$$(n+1)^2 - n^2 = 2n + 1$$

Examples:

$$5^2 - 4^2 = 25 - 16 = 9 \quad (2 \times 4 + 1)$$

$$10^2 - 9^2 = 100 - 81 = 19 \quad (2 \times 9 + 1)$$

5. SHORT TRICKS



Square of Numbers Near Base (100)

$$(100 - a)^2 = 10000 - 200a + a^2$$

Examples:

$$\begin{aligned} 98^2 &= (100 - 2)^2 \\ &= 10000 - 200 \times 2 + 2^2 \\ &= 9604 \end{aligned}$$

$$\begin{aligned} 97^2 &= (100 - 3)^2 \\ &= 10000 - 200 \times 3 + 3^2 \\ &= 9409 \end{aligned}$$

Square of Numbers Ending with 5

If a number ends with 5, then:

$$(10a + 5)^2 = a(a + 1)25$$

Examples:

$$15^2 = (1 \times 2)25 = 225$$

$$35^2 = (3 \times 4)25 = 1225$$

$$95^2 = (9 \times 10)25 = 9025$$

Square of Numbers Ending with 1

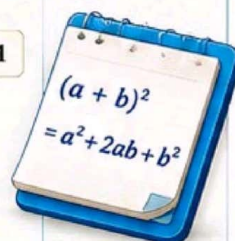
$$(10a + 1)^2 = a(a + 2)01$$

Examples:

$$11^2 = (1 \times 3)01 = 121$$

$$21^2 = (2 \times 4)01 = 441$$

$$31^2 = (3 \times 5)01 = 961$$



6. REAL-LIFE APPLICATIONS



Area of a square with side n units is n^2 square units.



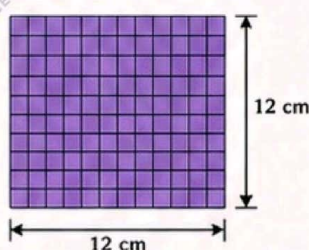
Used in fields like architecture, engineering, and construction.



Important in statistics, physics, computer graphics and more.

Example - Area of a Square

If the side of a square is 12 cm, then area = $(12)^2 = 144 \text{ cm}^2$



7. KEY TAKEAWAY

- ✓ Square of a number is the number multiplied by itself.
- ✓ Patterns help in quick calculation.
- ✓ Short tricks save time.
- ✓ Squares are useful in many real-life situations.



"Squares Build Strong Foundations in Mathematics and in Life."





SQUARE ROOT



$$(\sqrt{a})^2 = a$$
$$\sqrt{a} \geq 0$$

The square root of a number is a value which, when multiplied by itself, gives the original number.

1. DEFINITION

The square root of a non-negative number a is written as $\sqrt{a}$, such that $(\sqrt{a})^2 = a$ and $\sqrt{a} \geq 0$.

Example:

$$\sqrt{25} = 5, \text{ because } 5^2 = 25$$

$$\sqrt{0} = 0$$



Note:
Square root of a negative number is not real.

2. PERFECT SQUARES (1 TO 20)

n	n^2	n	n^2	n	n^2
1	1	8	64	15	225
2	4	9	81	16	256
3	9	10	100	17	289
4	16	11	121	18	324
5	25	12	144	19	361
6	36	13	169	20	400
7	49	14	196		

3. PROPERTIES

- $\sqrt{a} \geq 0$, for any real number $a \geq 0$
- $\sqrt{a^2} = |a|$
- $\sqrt{a \times b} = \sqrt{a} \times \sqrt{b}$ (for $a \geq 0, b \geq 0$)
- $\sqrt{\frac{a}{b}} = \frac{\sqrt{a}}{\sqrt{b}}$ ($b > 0$)
- $\sqrt{a^2 \times b} = a\sqrt{b}$ ($a \geq 0, b \geq 0$)
- $\sqrt{\frac{a}{b}} = \frac{\sqrt{a}}{\sqrt{b}}$ ($a \geq 0, b > 0$)

4. METHODS OF FINDING SQUARE ROOT

- Prime Factorization Method
- Long Division Method

Example (Prime Factorization Method)

Find $\sqrt{72}$

$$72 = 2 \times 2 \times 2 \times 3 \times 3$$
$$= 2^2 \times 3^2 \times 2$$

$$\sqrt{72} = \sqrt{2^2 \times 3^2 \times 2}$$

$$= 2 \times 3\sqrt{2} = 6\sqrt{2}$$

5. APPROXIMATE VALUES

$$\sqrt{2} \approx 1.414 \quad \sqrt{3} \approx 1.732 \quad \sqrt{5} \approx 2.236$$

$$\sqrt{6} \approx 2.449 \quad \sqrt{7} \approx 2.646 \quad \sqrt{10} \approx 3.162$$



Useful in mental calculations and estimations.

6. SHORT TRICKS

- Numbers ending with even number of zeros:

$$\sqrt{a \times 10^{2n}} = 10^n \sqrt{a}$$

Example:

$$\sqrt{3200} = \sqrt{32 \times 100} = 10\sqrt{32}$$
$$= 10 \times 4\sqrt{2} = 40\sqrt{2}$$

- Numbers near perfect squares:

If $n^2 < a < (n+1)^2$, then

$$n < \sqrt{a} < n+1$$

Example:

$$25 < 30 < 36$$

$$5 < \sqrt{30} < 6$$

7. REAL-LIFE APPLICATIONS



Used in geometry (diagonals, distance)



Physics (formulas involving distance, speed, energy)



Engineering & construction



Finance & statistics



SERIES AND PROGRESSIONS

A **series** is the sum of the terms of a sequence. A **progression** is a sequence in which the terms follow a specific pattern.

1. ARITHMETIC PROGRESSION (A.P.)

A progression in which the difference between consecutive terms is constant.

$$a, a+d, a+2d, a+3d, \dots, a+(n-1)d$$

First term (a) Common difference (d) n^{th} term

$$n^{\text{th}} \text{ term } (t_n) = a + (n-1)d$$
$$\text{Sum of first } n \text{ terms } (S_n) = \frac{n}{2} [2a + (n-1)d]$$

Example:

For A.P.: 2, 5, 8, 11, ...

$$a = 2, d = 3$$

$$t_5 = 2 + (5-1) \times 3 = 14$$

$$S_5 = \frac{5}{2} [2 \times 2 + (5-1) \times 3] = \frac{5}{2} (4 + 12) = 40$$

Key Points

- $d = t_2 - t_1 = t_3 - t_2$
- If $d > 0 \rightarrow$ A.P. is increasing
- If $d < 0 \rightarrow$ A.P. is decreasing

2. GEOMETRIC PROGRESSION (G.P.)

A progression in which the ratio between consecutive terms is constant.

$$a, ar, ar^2, ar^3, \dots, ar^{n-1}$$

First term (a) Common ratio (r) n^{th} term

$$n^{\text{th}} \text{ term } (t_n) = ar^{n-1}$$
$$\text{Sum of first } n \text{ terms } (S_n) = \begin{cases} \frac{1-r^n}{1-r} & \text{If } r \neq 1 \\ na & \text{If } r = 1 \end{cases}$$

Example:

For G.P.: 3, 6, 12, 24, ...

$$a = 3, r = 2$$

$$t_5 = 3 \times 2^{5-1} = 48$$

$$S_5 = 3 \frac{1-2^5}{1-2} = 3 \frac{1-32}{-1} = 93$$

Key Points

- $r = \frac{t_2}{t_1} = \frac{t_3}{t_2}$
- If $|r| > 1 \rightarrow$ G.P. is increasing
- If $0 < |r| < 1 \rightarrow$ G.P. is decreasing

3. IMPORTANT FORMULAS

- Sum of first n natural numbers:

$$1 + 2 + 3 + \dots + n = \frac{n(n+1)}{2}$$

- Sum of squares of first n natural numbers:

$$1^2 + 2^2 + 3^2 + \dots + n^2 = \frac{n(n+1)(2n+1)}{6}$$

- Sum of cubes of first n natural numbers:

$$1^3 + 2^3 + 3^3 + \dots + n^3 = \left[\frac{n(n+1)}{2} \right]^2$$



4. SPECIAL SERIES

- $1 + 2 + 3 + \dots + n = \frac{n(n+1)}{2}$
- $2 + 4 + 6 + \dots + 2n = n(n+1)$
- $1 + 3 + 5 + \dots + (2n-1) = n^2$
- $1^2 + 2^2 + \dots + n^2 = \frac{n(n+1)(2n+1)}{6}$
- $1^3 + 2^3 + \dots + n^3 = \left[\frac{n(n+1)}{2} \right]^2$

5. REAL-LIFE APPLICATIONS



A.P.: Used in savings plans, salary increments, construction steps, emissions data, etc.



G.P.: Used in population growth, compound interest, radioactive decay, loan repayments, etc.



Series: Used in statistics, physics, computer science, signal processing, and many more.

6. QUICK RECAP

Type	General Form	n^{th} Term	Sum of n Terms
A.P.	$a, a+d, a+2d, \dots$	$a + (n-1)d$	$\frac{n}{2} [2a + (n-1)d]$
G.P.	$a, ar, ar^2, \dots$	ar^{n-1}	$a \frac{1-r^n}{1-r}$ ($r \neq 1$) na ($r = 1$)



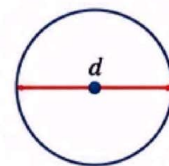
"Mathematics is not about numbers, equations, computations, or algorithms: it is about understanding." — William Paul Thurston





1. VALUE OF PI (π)

Pi (π) is the constant ratio of the circumference of a circle to its diameter.



$$\pi = \frac{C}{d}$$

C = Circumference
d = Diameter

1. VALUE

π is an irrational, non-terminating non-repeating decimal.

$$\pi \approx 3.14159265358979323846...$$

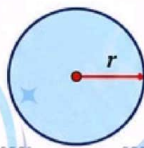
Common Approximations:

$$\pi \approx 3.14 \quad (\text{good for general use})$$

$$\pi \approx 22/7 \quad (\text{traditional \& useful})$$

$$\pi \approx 355/113 \quad (\text{more accurate})$$

2. KEY FORMULAS



$$\text{Circumference (C)} = 2\pi r$$

$$\text{Area (A)} = \pi r^2$$

$$\text{Diameter (d)} = 2r$$

$$\text{Arc Length (L)} = (\theta/360^\circ) \times 2\pi r$$

$$\text{Area of Sector} = (\theta/360^\circ) \times \pi r^2$$

where r = radius, θ = central angle

3. INTERESTING FACTS

- π has infinite digits without any pattern.
- It appears in many areas of mathematics, physics, engineering and nature.
- π is used in calculations involving circles, waves, probability, statistics, and more.
- Pi Day is celebrated on March 14 (3/14).



4. PLACE VALUE OF π (FIRST 20 DIGITS)

Digit	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
π	3	.	1	4	1	5	9	2	6	5	3	5	8	9	7	3	2	3	8	4	6

$$\pi = 3.14159265358979323846...$$

5. REAL-LIFE APPLICATIONS



Engineering



Architecture



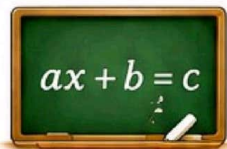
Physics



Computer Graphics



Navigation



2. ALGEBRA

Algebra is the branch of mathematics that uses symbols and letters to represent numbers and relationships.



1. BASIC CONCEPTS

- A variable is a symbol (like x, y, z) representing a number.
- A constant is a fixed number.
- An expression is a combination of variables, constants and operations.
- An equation shows equality between two expressions.

Example:

$$\text{Expression: } 3x + 5$$

$$\text{Equation: } 3x + 5 = 14$$

2. ALGEBRAIC IDENTITIES

- $(a + b)^2 = a^2 + 2ab + b^2$
- $(a - b)^2 = a^2 - 2ab + b^2$
- $(a + b)(a - b) = a^2 - b^2$
- $(a + b)^3 = a^3 + 3a^2b + 3ab^2 + b^3$
- $(a - b)^3 = a^3 - 3a^2b + 3ab^2 - b^3$
- $a^3 + b^3 = (a + b)(a^2 - ab + b^2)$
- $a^3 - b^3 = (a - b)(a^2 + ab + b^2)$

3. LINEAR EQUATION

General form:

$$ax + b = 0 \quad (a \neq 0)$$

Solution:

$$x = -\frac{b}{a}$$

Example:

$$2x + 5 = 15$$

$$2x = 10$$

$$x = 5$$

4. POLYNOMIALS

- A polynomial is an expression with one or more terms.

Example:

$$P(x) = 3x^3 - 2x^2 + 5x - 7$$

- Degree of Polynomial = Highest power of the variable (Here, degree = 3)

5. FACTORING

- Common Factor: $ax + ay = a(x + y)$
- Difference of Squares: $a^2 - b^2 = (a + b)(a - b)$
- Perfect Square Trinomial: $a^2 + 2ab + b^2 = (a + b)^2$
- Grouping: $ax + ay + bx + by = a(x + y) + b(x + y) = (a + b)(x + y)$

Example:

$$\text{Factorize: } x^2 + 5x + 6$$

$$x^2 + 5x + 6 = x^2 + 2x + 3x + 6$$

$$= x(x + 2) + 3(x + 2)$$

$$= (x + 2)(x + 3)$$

6. REAL-LIFE APPLICATIONS



Engineering & Physics



Economics



Computer Science



Everyday Problem Solving

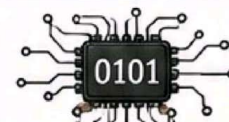
KEY TAKEAWAY

Algebra helps us model, solve and understand real-world problems using symbols and equations.



3. BINARY MATHEMATICS

Binary mathematics uses only two digits: 0 and 1. It is the foundation of digital systems and computers.



1. BINARY DIGITS

The binary number system (Base 2) uses:

0, 1

Each position in a binary number represents a power of 2.

2. PLACE VALUE IN BINARY

Position	7	6	5	4	3	2	1	0
Power of 2	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
Value	128	64	32	16	8	4	2	1

Example: $(1011011)_2$

$$= 1 \times 64 + 0 \times 32 + 1 \times 16 + 1 \times 8 + 0 \times 4 + 1 \times 2 + 1 \times 1$$

$$= 64 + 16 + 8 + 2 + 1 = 91_{10}$$

3. BINARY ADDITION

$$0 + 0 = 0$$

$$0 + 1 = 1$$

$$1 + 0 = 1$$

$$1 + 1 = 10 \quad (0, \text{carry } 1)$$

Example:

$$\begin{array}{r} 1011 \\ + 1101 \\ \hline \end{array}$$

$$\begin{array}{r} 1011 \\ + 1101 \\ \hline 11000 \end{array}$$

4. BINARY SUBTRACTION

$$0 - 0 = 0$$

$$1 - 0 = 1$$

$$1 - 1 = 0$$

$$10 - 1 = 1 \quad (\text{borrow } 1)$$

Example:

$$\begin{array}{r} 1101 \\ - 1011 \\ \hline \end{array}$$

$$\begin{array}{r} 1101 \\ - 1011 \\ \hline 0010 \end{array}$$

5. BINARY MULTIPLICATION

$$0 \times 0 = 0$$

$$0 \times 1 = 0$$

$$1 \times 0 = 0$$

$$1 \times 1 = 1$$

Example:

$$\begin{array}{r} 101 \\ \times 11 \\ \hline 101 \\ 101 \\ \hline 1111 \end{array}$$

6. BINARY TO DECIMAL QUICK METHOD

Step 1: Write the place values (powers of 2).

Step 2: Multiply each bit by its place value.

Step 3: Add all the results.

Example: $(11010)_2$

$$\begin{array}{r} 16 \quad 8 \quad 4 \quad 2 \quad 1 \\ \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \\ 1 \quad 1 \quad 0 \quad 1 \quad 0 \end{array}$$

$$= 1 \times 16 + 1 \times 8 + 0 \times 4 + 1 \times 2 + 0 \times 1 = 26_{10}$$

7. DECIMAL TO BINARY (DIVISION METHOD)

Step 1: Divide the number by 2.

Step 2: Write the remainder (0 or 1).

Step 3: Repeat with the quotient.

Step 4: Read remainders bottom to top.

Example: Convert $(25)_{10}$ to binary

$$25 \div 2 = 12 \quad R1$$

$$12 \div 2 = 6 \quad R0$$

$$6 \div 2 = 3 \quad R0$$

$$3 \div 2 = 1 \quad R1$$

$$1 \div 2 = 0 \quad R1$$

$$(25)_{10} = (11001)_2$$

8. APPLICATIONS



Computers & Processors



Digital Electronics



Data Storage



Networking & Security



Programming

KEY TAKEAWAY

Binary mathematics is simple but powerful — it drives all digital technology around us.



Mathematics is the language of logic, patterns and possibilities.

From π to Algebra to Binary — numbers build the digital world!



MAGIC SQUARES IN INDIA

Ancient Wisdom. Perfect Numbers. Timeless Legacy.

Magic Squares are special grids of numbers arranged so that the sum of numbers is the same in each row, column and diagonal.

“From ancient inscriptions to modern mathematics, India has a rich tradition of understanding patterns, numbers and perfection.”

1. ORIGIN AND HISTORY

- Magic Squares have been known in India for more than 2000 years.
- References are found in ancient texts like Atharva Veda, Brihat Samhita (by Varahamihira, 6th century CE) and ancient temples.
- They were used in astronomy, architecture, yantras, rituals and art.
- Indian mathematicians explored patterns, symmetry and numerical harmony.



यथा पिण्डे तथा ब्रह्माण्डे
(As in the body, so in the universe)



2. THE FAMOUS 3×3 MAGIC SQUARE

The earliest known magic square in India is the “Lo Shu Square” mentioned by Varahamihira.

4	9	2
3	5	7
8	1	6

Magic Constant = 15

Row sum = 15
Column sum = 15
Diagonal sum = 15

3. MAGIC SQUARES IN INDIAN TEMPLES AND ARCHITECTURE

- Magic Squares are carved on the walls, floors and ceilings of many temples.
- Believed to bring balance, positivity and protection.
- Examples:
 - Konark Sun Temple (Odisha)
 - Airavatesvara Temple (Tamil Nadu)
 - Melkote Temple (Karnataka)
 - Bhuleshwar Temple (Maharashtra) and many more.

16	3	2	13
5	10	11	8
9	6	7	12
4	15	14	1

4×4 Magic Square
(Found in Indian Temples)

4. EXAMPLE OF 4×4 MAGIC SQUARE

16	3	2	13
5	10	11	8
9	6	7	12
4	15	14	1

Magic Constant = 34

Row sum = 34
Column sum = 34
Diagonal sum = 34

WHY ARE THEY SPECIAL?



Symbolize harmony and balance.



Show mathematical beauty and symmetry.

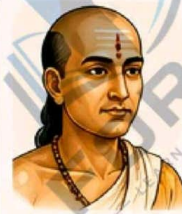


Connect mathematics with spirituality.



Inspire patterns in art, music, astrology, and vastu shastra.

5. INDIAN MATHEMATICAL GENIUS



Indian mathematicians like Aryabhata, Brahmagupta, Bhaskara II and others studied number patterns deeply.

Their work influenced mathematics across the world.

6. TYPES OF MAGIC SQUARES

Odd Order

(3×3, 5×5, ...)

Examples:

4	9	2
3	5	7
8	1	6

Easy to construct.
Always have a magic square.

Even Order

(4×4, 6×6, ...)

Examples:

16	3	2	13
5	10	11	8
9	6	7	12
4	15	14	1

More complex construction.

Singly Even Order

(6×6, 10×10, ...)

Need special methods.

35	1	6	26	19	24
3	32	7	21	23	25
31	9	2	22	27	20
8	28	33	17	10	15
30	5	34	12	14	16
4	36	29	13	18	11

Doubly Even Order

(4×4, 8×8, ...)

Easy pattern methods.

16	3	2	13
5	10	11	8
9	6	7	12
4	15	14	1

7. MODERN APPLICATIONS



Used in design, coding, puzzles and games.



Helpful in teaching patterns and logic.



Inspires algorithms and computer science.



Still used in astrology, vastu and numerology.



DID YOU KNOW?

- The 3×3 Lo Shu Square is believed to be mystical and is associated with the planet Mercury.
- The numbers 1 to 9 can create only one 3×3 magic square (in different rotations).

A TIMELESS LEGACY

Magic Squares in India are not just about numbers, they are a perfect blend of mathematics, art, science and spirituality.

They represent the Indian vision of order, harmony and infinity.

TRY THIS!

Verify the magic constant for the 3×3 and 4×4 squares.

Can you create your own magic square?

START



Numbers are the language with which God has written the universe.

– Galileo Galilei