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Subject Teacher
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Lecture No. 14: Module 1: Arithmetic, Algebra and Combinatorics

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July 5, 2025

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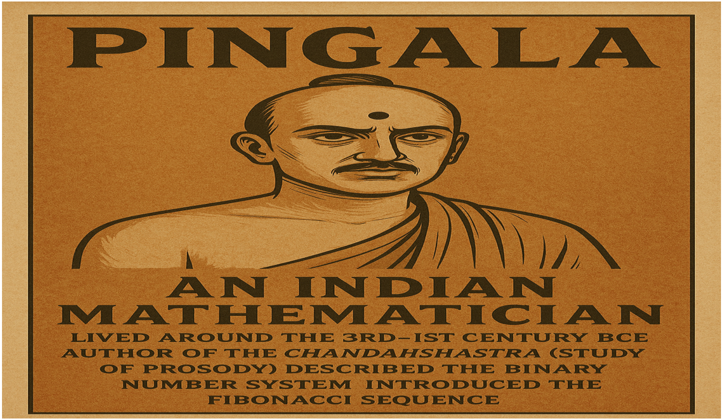
Pingala's Chandaḥśāstra (c. 2nd century BCE):



Pingala's Chandaḥśāstra (c. 2nd century BCE):

Sanskrit Verse 1: Prastāra (Expansion of Meters)

"dvau bhāvau laghu-guruḥ — tasmād dvirgunaḥ prastāraḥ"

Translation:

"There are two types (of syllables): laghu (short) and guru (long); hence, the total number of combinations (Prastāra) is a power of two."

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Pingala's Chandaḥśāstra (c. 2nd century BCE):

Modern Explanation:

For n syllables, the number of possible combinations of laghu and guru is: 2^n

E.g., For 3 syllables:

LLL, LLG, LGL, GLL, LGG, GLG, GGL, GGG $\rightarrow 8 = 2^3$

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Pingala's Chandaḥśāstra (c. 2nd century BCE):

Sanskrit Verse 2: Meru (Pascal's Triangle):

"ardhadvayāt upari ardhadvayam, evam urdhvam samāsataḥ"

Translation:

"Take pairs of numbers from the row below, add them to form the next row above—this builds the triangle step by step."

Pingala's Chandaḥśāstra (c. 2nd century BCE):

Modern Explanation:

This is a recursive description of Pascal's Triangle (Meru-prastaara), where each entry is the sum of the two directly below it.

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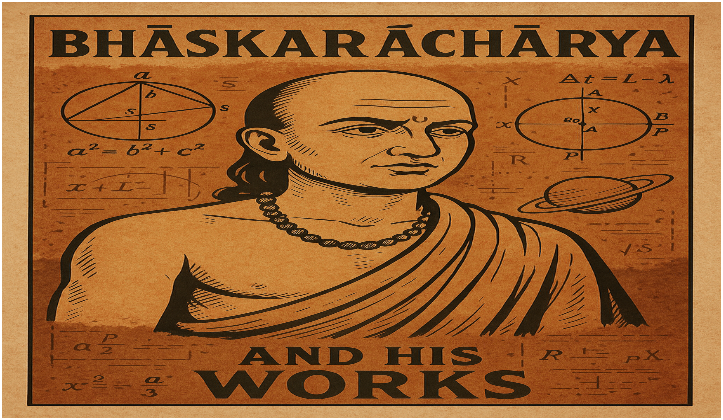
Bhaskaracharya's Līlāvatī (c. 1150 CE):



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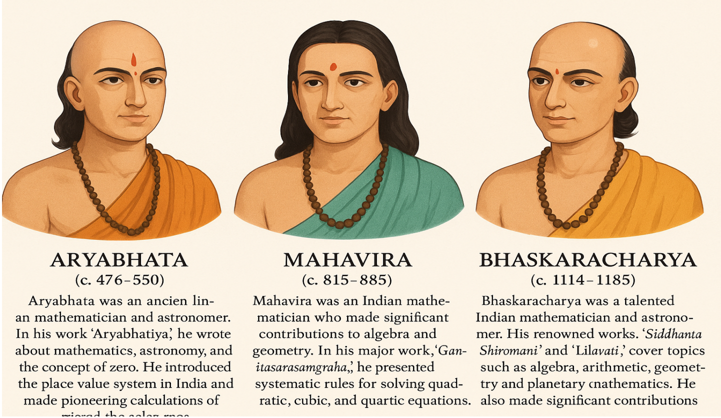
Bhaskaracharya's Līlāvatī (c. 1150 CE):



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Bhaskaracharya's Līlāvatī (c. 1150 CE):

Sanskrit Verse 3: Sum of Natural Numbers:

"ekāṅkadhṛte dviguṇitaṃ yutaṃ saṅkhyayā taduttareṇa bhaktaṃ —
tatsyāt sarvasaṅkhyānāṃ yogo madhyasthasaṅkhyābhyāṃ vā"

Translation:

"Double the first number minus one, add it to the number of terms, divide by 2 — the result is the sum of the series. Or take the average and multiply by the number of terms."

Bhaskaracharya's Līlāvatī (c. 1150 CE):

Modern Formula:

$$S_n = \frac{n}{2}(a + l)$$

or

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

$(\text{when} a = 1 \text{ and} d = 1)$

Bhaskaracharya's Līlāvatī (c. 1150 CE):

Sanskrit Verse 4: Permutations of Objects:

"padārthānām ekādhikānāṃ krameṇa gatiḥ syāt"

Translation:

"The number of arrangements (gati) of a number of distinct objects is the factorial of one more than the number."

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Bhaskaracharya's Līlāvatī (c. 1150 CE):

Modern Formula:

If there are n distinct items:

$$n! = n(n-1)(n-2)(n-3)\ldots 3.2.1$$

Example:

3 ornaments $\rightarrow 3! = 6$ arrangements.