Lecture No. 8: Module 1: Arithmetic, Algebra and Combinatorics

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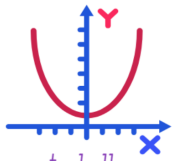

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Indian Mathematics

1. The Zero and the Decimal System: The early appearance of Zero
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3. The elementary operations like addition, subtraction, multiplication, division. Operations with fractions. Operations with zero. Squares and Cubes.
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Indian Mathematics

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Indian Mathematics

Traditional Indian Proportional Methods in Arithmetic

Trairashik, Vyasta-Trairashik, Paanchrashik, Saaptarashik :

Introduction:

Ancient Indian mathematics developed several rule-based methods for solving problems involving proportion, ratio, and unitary method. These methods were algorithmic and were widely used for solving commercial, astronomical, and geometrical problems. They are collectively known by names such as:

- Trairashika
- Vyasta-Trairashika
- Pancharashika
- Saptarashika

These appear in ancient mathematical texts like Lilavati by Bhaskaracharya and Ganita Sara Sangraha by Mahaviracharya.

Traditional Indian Proportional Methods in Arithmetic

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Trairashika – The Rule of Three :

Definition::

"Trairashika" literally means 'Three-quantity method', and refers to the Rule of Three, used to solve direct proportion problems.

Structure:

Given three quantities:
If A is to B, then C is to what?
That is,

$$\frac{A}{B} = \frac{C}{X} \implies x = \frac{B.C}{A}$$

This helps in finding the unknown fourth term.

Traditional Indian Proportional Methods in Arithmetic

Trairashika – The Rule of Three :

Example: If 5 men can complete a work in 8 days, how many days will 10 men take?

Here:

5 men $\rightarrow$ 8 days

10 men $\rightarrow$?

Apply Trairashika (inverse proportion):

$$x = \frac{5 \times 8}{10}$$

$$= 4$$

4 days

Traditional Indian Proportional Methods in Arithmetic

Vyasta-Trairashika – Inverse Rule of Three:

Definition::

"Vyasta" means inverse. This method applies to cases where more of one leads to less of another, i.e., inverse proportion.

Structure:

Used when:
Increase in one quantity leads to decrease in another.
Formula becomes:
$x = \frac{A.C}{B}$ (but account for inverse relationship)

Traditional Indian Proportional Methods in Arithmetic

Vyasta-Trairashika – Inverse Rule of Three:

Example: If 8 workers complete a job in 12 days, how many days will 16 workers take?

$$x = \frac{8 \times 12}{16}$$

$$= 6$$

6 days

Traditional Indian Proportional Methods in Arithmetic

Pancharashika – The Rule of Five:

Definition::

"Panch" means five. This method deals with compound proportions, i.e., two or more proportional relationships combined to find a solution.

Structure:

Used when there are two successive rule-of-three relations:
If $A : B$ and $C : D$ then what is E :?

Traditional Indian Proportional Methods in Arithmetic

Pancharashika – The Rule of Five:

Example: If 6 men earn 1200 in 8 days, how much will 9 men earn in 12 days?

Step 1: Apply first rule of three on men:

6 men $\rightarrow$ 1200

9 men $\rightarrow \frac{9}{6} \times 1200 = 1800$

Step 2: Apply rule on days:

8 days $\rightarrow$ 1800

12 days $\rightarrow \frac{12}{8} \times 1800 = 2700$

Answer: 2700

Traditional Indian Proportional Methods in Arithmetic

Saptarashika – The Rule of Seven:

Definition::

"Sapta" means seven. This is used for multi-variable compound proportion problems involving three or more ratios.

Structure:

Used when three interrelated ratios determine a final unknown.

$$x = \frac{B.D.F.\ldots.}{A.C.E.\ldots.} \times G$$

This is essentially an extended chain rule of proportional reasoning.

Traditional Indian Proportional Methods in Arithmetic

Saptarashika – The Rule of Seven:

Example: If 4 men can reap 8 acres in 6 days, how many acres can 6 men reap in 9 days?

- 4 men $\rightarrow$ 8 acres
- 6 men $\rightarrow \frac{6}{4} \times 8 = 12$ acres
- 9 days $\rightarrow \frac{9}{6} \times 12 = 18$ acres

Answer: 18 acres

Traditional Indian Proportional Methods in Arithmetic

Historical Significance :

Historical Significance

- These methods reflect a highly systematic approach to arithmetic used in trade, astronomy, and daily life in ancient India.
- Bhaskaracharya included Trairashika and Pancharashika in Lilavati as algorithms for practical problem-solving.
- These proportional rules are the forerunners of modern unitary methods, cross-multiplication, and chain rule techniques.