ALGEBRAIC TECHNIQUES IN VEDIC MATHEMATICS:- A HISTORICAL AND COMPUTATIONAL STUDY

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Abstract:-

Vedic Mathematics was written by Krishna, an Indian monk, and was first published in 1965. It contains lists of mathematical techniques that the author says were derived from the Vedas, which he claims contain all mathematical knowledge. This article examines mathematical processes utilizing Vedic mathematics, starting with the basics of Vedas mathematics, such as the meaning of Vedas mathematics and the meanings of 16 formulas. The four Vedas are the Ayurveda, Rigveda, Atharvaveda, and Samaveda.) Another option is to use Vedic equations (Vedic Mathematics is a logic and math system based on sixteen formulas and thirteen sub formulas with simple principles and concepts). In addition, the many operations in Vedas mathematics, such addition, subtraction, multiplication, and so on, as well as the formulas and examples utilized in the Vedas, are covered in this review article. They have a bright future ahead of them, and straightforward explanations will help kid's better grasp mathematics. Because it is now required reading in all high schools. Vedic mathematics is an interesting, speedy, simple logical & integral part of our ancient Indian culture using traditional mathematics, which finds its origin in our Vedas especially "Atharva Veda" and is mainly based on 16 principles called "Sutras" & 13 Sub-Sutras. Applied to almost every branch of mathematics. The interesting part in Vedic mathematics is, you can mostly check your calculation and know whether you are right or wrong in few seconds and that makes it more enjoyable. Here, discuss some applications of Vedic mathematics in one of its field i.e. Algebra and see how it saves a lot of time & efforts in solving the problems.

In terms of Efficiency and Simplicity, Vedic Methods are performing exceptionally well. It actually mirroring traditions of versatile and varied methods in mathematics, as a result there are several tactics to simplify equations Arithmetic computations cannot be obtained faster by any other known method. This paper describes the different techniques used in ancient Vedic mathematics for solving algebraic equations.

Keywords - Vedic Mathematics, Sutras Digit, Formula, Mathematics, Operation, Vedas. Sutras, Sub-Sutras, Algebra, Atharva.

1. Introduction:-

The Vedas & Upaveda are unlimited storehouse of knowledge, which were probed extensively by and this led to the development of the sixteen Sutras and thirteen Sub-Sutras. Therefore, developed methods & techniques, elaborating the principles contained in these Sutras & Sub- Sutras is called Vedic mathematics.

Sutras, which are basically single line phrases, is based on a rational way of thinking, which improves intuition, creativity and emphasizes on development of our mental abilities, which is the bottom-line of the mastery, that is seen, in mathematical geniuses of the present and the past. The

Sutras are correlated. A single Sutra/Formula can be used to perform various arithmetic calculation, all the basic calculations can be done using different available methods, and it is up to the students to choose the method they find to be more comfortable. Applications of the sixteen Sutras can be found in the different branches of mathematics viz. geometry, calculus, arithmetic's, trigonometry etc. and these Sutras make all the mathematical calculations easy, fast and error free, which in turn, makes mathematics more joyful & is a great confidence booster for students who fear mathematics. No wonder then, that, this Vedic mathematics is being adopted by various professionals, scientists, taught in some of the most prestigious institutes worldwide & especially students preparing for various big competitions, to achieve better performance.

2. Vedic Sutras for solving simultaneous equation Vedic Sutras for solving simultaneous equation are

- Paravartya Yojayet
- Anurupye Sunyamanyat
- Sank Alana Vyavakalana-bhyam

2.1Paravartya Yojayet

This method is applicable for all sorts of linear simultaneous equations. A simple idea for finding value of x, start with y – coefficient and independent terms and cross multiply them in the forward direction, the sign between the two cross multiplication is minus (-). For y, start with the independent term and x – coefficient and cross- multiply them in the backward direction. The sign between the cross-multiplication result is minus (-). For the result of the denominator, take the coefficient of variable only and cross-multiply then in backward direction.

Suppose, have the following set of simultaneous equations: -

$a1x + b1y = c1$

$a2x + b2y = c2$

In order to get the numerator of x , leave the coefficient of x and write the coefficient of y and the independent term and cross multiply them with a minus sign in between the cross product in rightward direction as shown here:-[4-6]

b1 c1

b2 c2

$= b1\ c2 - b2c1$

Again, to get numerator of y, leave the coefficient of y and take only the coefficient of x and the independent term into consideration. As know the sutra moves in a cyclic order, so start with independent term first. Cross multiplication of the independent term and coefficient of x will give the numerator of y.

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c1 a1

c2 a2

Here is an example to understand the entire concept by this simple diagrammatical structure.

Numerator of x Numerator of y Denominator

b1 c1 a1 b1

b2 c2 a2 b2

Here is an example to understand this concept.

Example 1: Simplify for x and y,

3x + 4y = 10;

4x - 2y = - 16

Coefficient of y Independent term

4 10

-2 -16

x =

Coefficient of x Coefficient of y

3 4

4 -2

Independent Term Coefficient of x

10 3

-16 4

y =

Coefficient of x	Coefficient of y
3	4
4	-2

X=-2, Y=4

2.2. Anurupye Sunyamanyat :

This Vedic sutra says –

If one is in ratio, the other one is zero, it means when the ratio of x or y is equal to that of independent term, put the ratio of y or x = 0. To understand here is an example:

Example 2: Simplify for x and y

8x+6y = 80;

24x+13y

The ratio of coefficients of x is 1:3 which is equal to the ratio of the independent term. So according to above sutra, we put y = 0 in either of the equations to get the value of x.

For y=0, 8x=80, x =10

For x=10 y = 0,

is the solution.

2.3. Sankalana Vyavakalana-bhyam

This sutra simply says: Addition and subtraction.

When there is coefficient of x in 1st equation is equal to the coefficient of y in 2nd equation and vice versa. This sutra works well. To understand this here is an example:

Example3: Solve for x and y.

1955x – 476y=2482 ….(A)

476x – 1955y= -49131 …..(B)

Adding (A) and (B), equation becomes,

2431x -2431y = -2431;

$\Rightarrow$ x- y=-1 ……….(c)

Subtract (B) from (A);

1479x- 1479y= 7395;

$x+y=5$ ....(D)

Add (c) and (D), value of x=2 subtract (D) from (C) value of y=3.

3. Multiplication and Division using Vedic Mathematics

The Multiplication of polynomials in Vedic Mathematics can be done by using Urdhva Tiryangbhyam Sutra.

There are three categories for this.

1. Multiplication of Binomials.

2. Multiplication of polynomials with an equal number of terms..

3. Multiplication of polynomials with an unequal number of terms.

3.**1. <u>Multiplication of Binomial's</u>:-**

Urthva Tiryagbhyam means "vertically and crosswise", a Sutra used for fast multiplication in Vedic Mathematics.

We will use it for multiplying two binomials:

$(ax+b)(cx+d)$

The method involves 3 simple steps:

- **Vertical Multiplication of first terms**

First: acx^2

- **Crosswise multiplication of outer & inner terms, then add**

$(ad+bc)x$

- **Vertical multiplication of last terms**

bd

So the product is:-

$(ax+b)(cx+d) = acx^2 +(ad+bc)x+b$

Example 1 :- Multiply $(3x+4)(2x+5)$

Step1 - Vertical multiplication of first terms

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

Step2- Crosswise multiplication

(i) $3x \times 5 =15x$

(ii)$4\times 2x =8x$

Add them:

15x+8x =23x

Step3 - Vertical multiplication of last terms

4×5 = 20

Final Answer

(3x+4) (2x+5) = $6x^2$+23x+20

3. 2. Multiplication of polynomials with an equal number of terms.

The multiplication of polynomials with an equal number of terms in Vedic Mathematics if primarily done using the Urdhva Tiryagbhyamn sutra. Meaning "vertically and crosswise". This method provides a systematics, single-line approach to multiplication by working with the coefficients of the polynomials.

For two polynomials with n terms, there will be (2n-1) steps in the process, moving from right to left (or left to right). The general algebraic principle for two binomials (ax+b) and (cx+d) result is

$$=acx^2 +(ad+bc)x+bd,$$

Where the coefficients are obtained by the vertical and crosswise pattern.

Example:- Multiplying two trinomials

Multiply (x^2+2x+1) by ($2x^2$+4x+3).

{Coefficients: 1,2,1 and 2,4,3}

l applications have shown that Vedic mathematics is useful in modern fields such as e

step1 (Right)	tep2	step3 (Middle)	step4
1×3	2×3)+(4×1)	1×3)+(2×1)+(2×4)	1×4)+(2×2)
	-4=10	3+2+8=13	4+4=8

Combine the results, managing carry-overs from right to left:

- Step 1: 3(write down 3)
- Step 2: 10 (write down 0, carry over1)
- Step 3: 13+1 (carry-over) = 14 (write down 4 carry over 1)
- Step 4: 8+1 (carry-over) = 9 (write down 9)
- Step5 : 2(write down 2)

The coefficients are 2,9,4,0, and 3, corresponding's to the powers of x from x^4 downwards (since $x^2 \times x^2=x^4$).

Answer: $2x^4+9x^3+4x^2+0x+3$,

Or simply $2x^4+9x^3+4x^2+3$.

3.3. Multiplication of polynomials with an unequal number of terms.

To multiply polynomials with an unequal's number of terms in Vedic Mathematics, use the Urdhva Tiryagbhyam (vertical and crosswise) method.

This involves systematic multiplication of each term from the first polynomial by each term from the second, and them combining like terms, which is a structured approach to what is often called the standard grid or lattice method.

4. Comparison of Algebraic Techniques in ancient and modern time:-

(1). Ancient Algebraic Techniques:- Ancient mathematician's (such as Diaphanous, Brahmagupta, and AI- Khwarizmi) solved algebraic problems mostly using words and rhetorical explanations rather than symbols.

Example:-

Instead of writing x+5 =12,

Ancient mathematicians described it in words like:

"Find a number which when increased by five becomes twelve."

Advantages of Ancient Techniques:-

(i) Easy to understand in simple problems.
(ii) Helped in the development of early mathematical thinking.
(iii) Useful for teaching basic arithmetic and reasoning.

Disadvantages of Ancient Techniques:-

- Problems were written in long sentences, making them time-consuming.
- Difficult to solve complex equations.
- Lack of symbols made calculations less efficient.

(2).Modern Algebraic Techniques:-

Modern algebra uses symbols, variables, and formulas to express mathematical relationships. These techniques developed mainly after the work of mathematicians like Rene Descartes and Isaac Newton.

Example:-

1. Instead of writing the equation in words, we write:

$$x+5=12$$

Solution:- $x= 12-5 = 7$

2. Ancient Technique

Multiply (3x+4)(2x+5)

Step1 - Vertical multiplication of first terms

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

Step2- Crosswise multiplication

3x ×5 =15x

4×2x =8x

Add them:

15x+8x =23x

Step3 - Vertical multiplication of last terms

4×5 = 20

Final Answer

(3x+4) (2x+5) = $6x^2$+23x+20.

Modern Techniques

Multiply (3x+4)(2x+5)

= $6x^2$ + 15x + 8x +20

= $6x^2$ +23x + 20.

Advantages of Modern Techniques:-

- Short and clear representation of problems.
- Easier to solve complex equations and large calculations.
- Widely used in science, engineering, and technology.

Disadvantages of Modern Techniques:-

(1) Requires understanding of symbols and algebraic rules.
(2) Can be difficult for beginners without basic knowledge of algebra.

Main Finding:-

The comparison shows that modern algebraic techniques are more efficient and powerful, but they are based on the fundamental ideas developed in ancient mathematics**.** The comparison shows that ancient techniques gives answer in long time and long process and modern techniques gives answer in very short time.

1. Ancient Algebra Was Mostly Rhetorical:-

In ancient civilizations such as **Babylonia**, **Egypt**, **India**, and **Greece**, algebra was written mainly in **words rather than symbols**.

I. Problems and solutions were explained in sentences.
II. There was **little or no symbolic notation** like x,y,+,=x, y, +, =x,y,+,=.
III. Methods were often **geometric or arithmetic**.

Example: Mathematicians like Diaphanous and Brahmagupta solved equations but described the steps verbally.

2. Modern Algebra Uses Symbolic Notation:-

Modern algebra uses **symbols and formulas** such as:

- variables (x,yx, yx,y)
- operations (+,−,×,÷+,-, \times, \div+,−,×,÷)
- equations and functions

Symbolic notation was developed mainly after the work of mathematicians like René Descartes in the 17th century.

3. Modern Techniques Are More General and Efficient

- Ancient methods solved **specific types of problems**.
- Modern algebra provides **general formulas and rules** that can solve many problems quickly.

Example: Quadratic equations now use the formula

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

4. Ancient Work Laid the Foundation

Although ancient algebra was less symbolic, it **established the basic ideas** of solving equations and manipulating numbers, which later developed into modern algebra.

5. Conclusion

Therefore, while applying Vedic mathematics one can versatility in solving problems and at the same time, this helps to decide on the best method possible in solving a particular type of problem. The beauty of Vedic mathematics is in its inventiveness, which one experiences while applying. As one can see in the above methods that with good practice of the Vedic mathematics one can do time consuming complex Problems far more easily and faster. The 16 sutras (formulas) and the 13 sub- sutras are applicable across various branches of mathematics, including basic arithmetic, geometry calculus, and different types of algebraic equations (linear. Quadratic, cubic,etc.).Research practicngineering (e.g., in the design of high- speed processors and digital signal processing operations) and competitive examinations where speed and accuracy are crucial.

Therefor we conclude that the Modern algebraic techniques are better and more efficient, but ancient techniques are still important because they laid the foundation for modern algebra. Modern algebra uses symbols, variables, and formulas, which make mathematical expressions short, clear, and easy to solve .Ancient algebraic problems mostly, wrote in words, which made long and complicated problems difficult to handle.

6. Future Scope of Vedic Algebraic Techniques:-

The **future scope of Vedic algebraic techniques** (based on principles from Vedic Mathematics by Bharati Krishna Tirtha) is quite promising in several areas of mathematics and education.

1. **Improving Mental Calculation Skills:-**

Vedic algebraic techniques provide fast methods for solving algebraic expressions and equations mentally.

- Students can perform calculations **quickly and accurately.**
- It reduces dependence on calculators for basic algebra.

2. **Enhancing Mathematics Education:-**

These techniques can make algebra **simpler and more interesting for students.**

- Helps reduce fear of mathematics.
- Encourages logical thinking and creativity in problem solving.

3. **Application in Competitive Exams:-**

Vedic methods help in **faster calculations**, which is very useful in exams where time is limited. Examples include exams conducted by organizations like Union Public Service Commission and Staff Selection Commission where speed and accuracy are important.

4. **Use in Computer Algorithms:-**

Some researchers study Vedic techniques to design **efficient algorithms for arithmetic operations** in computer science and digital systems.

These methods may help improve speed in processors and numerical computations.

5. **Research and Mathematical Development:-**

There is potential for further research in the field of algebra by analysing and extending Vedic methods. Mathematicians may develop **new shortcuts and alternative problem-solving approaches.**

6. **Integration with Modern Mathematics**

Future studies can combine **Vedic techniques with modern algebraic methods** to create more effective learning tools and computational techniques.

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