An Efficient, Buzzword Explanation of Vedic Mathematics Sutras

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Abstract - *The Vedic method of Indian mathematics is thought to be ancient. It has acted as a priceless gift to the nation through ancient eras of India. The Vedic mathematics was constructed using 16 formulas called sutras and 13sub-sutras(sub formula). The Vedic mathematics is designed in a way that calculations are carried out mentally. The main fact about Vedic mathematics was, for any difficult problem the answer should be calculated in one line. Vedic formulas can be used in these areas and often applied to practical, trigonometric, conic, and differential, and advanced mathematics. Vedic mathematics is a part of four Vedas Sthapathya-Veda, which covers the concepts of civil engineering and architectures this is an upa-Veda of atharva Veda. Sutra is given a very short formula to carry out difficult mathematical calculations in a very easy and simple manner and to executing them mentally. These sutras are used for multiplications, division, factorization, recurring decimals and solutions of simple equations. Quadratic equations, integration by partial fraction and differential calculus are used. Some topics of geometry such as Pythagorean theorem, and some theorems of Apollonius and it also covers more advanced mathematics such as analytical expressions of straight line and analytical conics.*

***Key Words*: Vedic mathematics, sutras, substraction, multiplications, division, quadratic equations.**

1. INTRODUCTION

Vedic mathematics was rediscovered from Vedas in between 1911 and 1918 [11] by Sri Bharathi Krishna tirthagi. He is better known bygurudeva or jagadguruji. The reconstruction of sutras mainly gathered from the atharva Veda [9]. Vedic mathematics sutras are also applicable even in astrology. The mathematics can also be usedto check out the answer whether it is correct or not. The term "Vedas" is a Sanskrit word means divinely revealed and it is the store house of all knowledge [10] It is not only related to the spiritual matters but also to the humanity. The sutras in the Vedic mathematics are designed in a way that naturally how human mind will work. Vedic mathematics is a kind of magic. Vedic mathematical technique will reduce the time, area and power consumption. This mathematics is unique and makes it easy and enjoyable for learning. The nine important features of Vedic mathematics are coherence, flexible and it improves mental power creatively. It is applicable for everyone and it increases the mental eligibility, efficient and fast[14]. Vedas are the ancient evidence of human knowledge and acquaintance and it was written about 5000 years ago[1]. By using this technique it will increase the step up to 15 times faster than actual technique [2]. The main beauty of Vedic mathematics is to reduce complex calculations in to simple one. In these sutras urdhva-triyagbhyam is best for the multiplication because it is applicable to all cases and it consumes less power and works at high speed. Generally Vedic mathematics sutras consume less power, silicon area and it is high speed when comparing to various other multipliers.

The sixteen sutras are as follows.

EkadhikenaPurvena

It means " **By one more than the previous one**". This sutra is mainly used to square the numbers and also used for the multiplication of two numbers under certain condition.

This particular kind of multiplication is used to multiply numbers whose first figures (numbers) add up to 10,100,1000…

The steps involved in the multiplication of two numbers.

Step 1: Multiply the last digits of the two numbers.
Step 2: The previous digits of the two numbers should be equal, if it satisfies, then previous digits × (next consecutive number).
Example-1: Square of 35 (i.e. 35 x 35)

Step 1: If the sum of the last digits is equal to 10 then multiply last digits 5x5=25.
Step 2: Previous digits should be same then previous digits x next consecutive number ,3x (3+1)= 3 x4 = 12 (Here, 4 is ekadhik of 3.)
35^2 = (3 x 4)/ (5 x 5) = 1225
The square of 35 is 1225.

Example 2: Multiply 26 and 24.

Step l: Sum of the last digits. i.e. 6+4=10,then multiply last digits 6x4=24.
Step2: Previous digits of the two numbers should be same then,
2x(2+1) = 2x 3 =6
i.e. 26x 24 = (2x3)/(6x4) = 6/24 = 624
The result for the multiplication of 26 and 24 is 624.

2. Nikhilam Navatascaramam Dasatah

It means " **All from 9 and the last from 10** "
It subtracts from nearest power of 10 or 10^n.

Example: Subtract 789 from 1000

7 8 9
↓ ↓ ↓
2 1 1

Here all from 9 last from 10 means subtract 7 from 9, 8 from 9 and 9 from 10, so we get 211

from 10000	from 1000	from 100
2772	754	97
↓↓↓↓	↓↓↓	↓↓
7228	246	03

The total of the pairs of these numbers is a foundation 2, 10, 100, 1,000, and 10,000,000made it possible to divide by standard denominators like 10, 100, 1000
In multiplying numbers closer to bases like 10, 100, 1000, the mixture may be used in a highly efficient method to generate 10. The multiplication operation with the Nikhilam. The discrepancy between the amount and the basis is considered a difference. A positive or negative deviation may occur.

Step-1: The procedure is called Nikhilam multiplication since divergence is obtained from the sutra of Nikhilam.

Step-2: The two numbers are written below each other. On the right page, the deviations are written.

Step-3: There are two sections for the answer, one at the left and the other at the centre. A slant line or vertical line may be drawn i.e. a dash to differentiate the two pieces.

Example 1: Multiply: 8 x 7

8 | -2 (10 – 8 = 2 deviation)
x 7 | -3 (10 – 7 = 3 deviation)
5 | 6

Example 2: Multiply: 96 x 98

96 | -04 (100 - 96 = 04 deviation)
x 98 | -02 (100 – 98 = 02 deviation)
94 | 08

3. Urdhvatiryakbhyam

This sutra means "**vertically cross wise**" to multiply two numbers by the sum of N and the multiplication process for the decimal and binary numbers systems is same.

The steps involved in the calculation for two digits decimal number are ....

Suppose we have to multiply (ab x cd).

Step-3 step-2 step-1

a b a b a b

c d c d c d

Example: Solve 32 X 23

Step-3 step-2 step-1

3 2 3 2 3 2

2 3 2 3 2 3

(3x2=6) (3x3 + 2x2) (2x3)

32x23 = (3x2) / (3x3 + 2x2) / (2x3)
= 6 / 13 / 6
= 736.

4. Paravartya Yojayet

It means **"Transpose and Apply"** this sutra is applicable when divisor should be greater than power of 10 the steps involved in the calculation are....

Step 1 : Divisor should be greater than power of 10

Step 2 : Write the divisor leaving the second digit, and write below the divisor in negative sign i.e. (x) from left to right

Step 3 : Write the dividend to the right leaving the last digit and mention it as reminder write the first digit as it and multiply that with x and add with the second digit and continue the process until last digit

Step 4 : Finally the last digit is remainder and the digits before last digits are mentioned as quotient.

Step 5 : The last digit is the remaining digit, and a quotient is the result on the left.

Example 1 : Divide 1225 by 12.

Step 1: (going from left to right): Take the first digit, use a negative symbol, and put it below the divisor to acquire the remaining digits.
12
-2

Step 2 : to the right of D Separate the last decimal position of an integer from the first.

i.e., 12 122 5
-2

Step 3 : Underdividend; write the first digit to the left of the decimal below the horizontal line Divide the digit by 2, then compose the product and sum.

i.e., 12 122 5
-2 -2

10

Since 1 x –2 = -2and 2 + (-2) = 0
We get the sum of two decimals as '00' Multiply the second product thus obtained by 2 and compose the corresponding amount as a consequence in the third position.

12 122 5
- 2 - 20

102 5

Step 4 : Continue the process to the last digit.

i.e. 12 122 5
- 2 -20 -4

102 1

Step 5: The sum of the last digit is the Remainder and the result to its left is
Quotient.
Thus Q = 102 and R = 1

5. Sunyamsamyasamuccaye

It means "when sum is same that sum is Zero", this sutra is used when same sum occurs equate that sum to zero. This sutra is applicable under six cases are...

Step 1: When the common factor occurs, and then equates that common to zero
Step 2: If the numerator are same then sum of the denominator is equate to zero
Step 3: Sum of denominator on left side equal to the right side then equate that sum to zero .
Step 4: When sum of the numerator and denominator is equal on both sides then equate that sum to zero .
Step 5: If it having any common term on either the numerator or denominator on both sides of the equation then equate the sum of numerator and denominator on either side equal to zero
Step 6: sum of the numerator and sum of the denominator are equal then equate either the sum of numerator or denominator to zero
If the difference of the numerator or denominator is same then equate the difference of either the numerator or denominator to zero
Example :

Step 1 : 3 (X + 2)= 7 (X + 5) , then equate(X + 5) = 0

Step 2 : 7 / (X + 2) = 7 / (X + 5) numerators are same so sum of denominator (X + 5) = 0

Step 3 : 1 / (X + 2) + 1 / (x - 7) = 1 / (X - 9) + 1 / (X - 4) sum of the denominator are same so sum of denominator (X + 5) = 0 .

Step 4 : (x + 2) / (X + 5) = (X + 5 / (X + 2) sum of numerator and denominator are same so sum (2X + 7) = 0 .

Step 5 : (2X + 3) / (4X + 5) = (X + 1) / (2X + 3) common factor on either numerator or denominator of either side so sum . (3X + 4) = 0.

Step 6 : (2 x 5)/ (x + 2) = (x + 2) / (2X - 5)

1. (2X + 5) + (X + 2) = (X+ 2) + (2X + 5) are same so, (3X + 7) = 0

2. (2X + 5) - (x + 2) = (X + 2) - (2X + 5) are same so, (X + 3) = 0) .

6. Anurupyesunyamanya

It means "**If one is the ratio other is zero**", this sutra is mainly used for the values of unknowns in the two linear algebraic equations. According to this sutra the steps involved in calculating values of unknown variable are…

Step 1: Taking the co-efficient of the variables as well as the constant.
Step 2: Taking y-coefficient ratio. If the ratio of coefficient of y and constant are equal then take x value as zero by using the value of x find y.

Example: Solve 5x + 8y = 3 and 3x + 40y = 15.
Step 1: The co-efficient y are in the ratio of 8 : 40 =1 : 5, the ratio of constant as 3 : 15 =1 : 5
Step 2: The ratio of y co-efficient and constant is same then let's take x= 0 and substitute x in any one of the equations. and solve it for y ie taking equation 8y= 3 And 40y = 15 then y = 3 / 8.

The values of variable x and y are 0 and 3 / 8 respectively.

7. Sankalana vyakalanabhyam

The statement in this Sutra implies "by addition and subtraction." It can be applied in solving a particular types of simultaneous equations that have the x and y coefficients interchanged.

Example: aX + bY= C1→(1)

bX + aY=C2 →(2)

The steps involved in solving equations are..

Step 1: If the above condition is satistied then add equation 1 and equation 2, the addition of the two equations will give another equation named as equation 3

Step 2: Subtract the equation1 and 2, the resultant equation in step 2 is named as equation 4.

Step 3: Solve the equation 3 and 4, it result either X or Y Veda, substitute that X and Y value in either equation 3 or 4 we get Y or X respectively.

Example: 32X + 23Y= 75→(1)

23X + 32Y= 30→(2)

Step 1: Addition of equation (1) and (2),

(32X+23Y) + (23X +32Y) = 75 + 30

55X + 55Y = 105

11X + 11Y = 21 →(3)

Step 2: Subtraction of equation (1) and (2)

(32X+23Y) - (23X +32Y) = 75 - 30

9X - 9Y = 45

X – Y = 5 →(4)

Step 3: Solve equation (3) and (4)

Slove 11X+11Y = 21 and X - Y = 5

X=38/11 Then substitute x value in equation (4), so 38 / 11 - Y= 5

Y= -17/11,The result is X= 38 / 11 and Y = -17/11.

8. Purana puranabhyam

It means "**The by completion or non-completion"** thus sutra is used to find the roots of the cubic equation The steps involved in the calculation of roots are

Step 1: Check for the nearest cubic formula i.e. $(X - a)^3$, for the given cubic equation.

Step 2: Subtract the nearest cubic equation and the given cubic equation and then add the result from the subtraction on both side of the given cubic equation.

Step 3: The resultant equation contain common terms on both side of the equation, so replace that common term with another Variable, and check for the values which satisfies the condition.

Step 4: The values which satisfies the condition are taken as roots of the equation.

Example: Solve $X^3+8X^2+17X+10 = 0$.

The given cubic equation is required to $(X+3)^2$

We know $(X+3)^3= X^2+9X^2+27X+27$

So adding on the both sides, the term $(X^2 + 10X + 17)$,

we get

$X^3+8X^2+17X+10+X^2+10X+17= X^2+10X+17$

i.e. $X^3+9X^2+27X+27 = X^2+6X+9+4X+8$

i.e. $(X+3)^3 = (X+3)^2 + 4(X+3) – 4$

$Y^3 = Y^2+4Y–4$ for $Y = X+3$

y = 1, 2, -2.

Hence x = -2, -1, -5

Thus, purana facilitates factorization

We may also use purana in solving biquadratic equations.

9. Chalana Kalanabhyam

means "**differential calculus**" This formula is primarily used to determine the roots of a quadratic equation

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

In this formula a,b and c are the co-efficient of x^2 , x and constant respectively.

Example: Slove $9X^2 -3X-2=0$ by using formula.

Here, a = 9, b = -3, c= -2 .

Then $X= \frac{-(-3)\pm\sqrt{9-4(9)(-2)}}{2(9)}$

$$X = \frac{3 \pm \sqrt{81}}{18}$$

$18X = 3 \pm\sqrt{81}$

$18X = 3 +\sqrt{81}$ **or** $18X = 3 -\sqrt{81}$

18X = 3 +9 **or** 18X = 3 −9

18X = 12 **or** 18X = -6

X=2/3 **or** X = -1/3

10. Yaavadunam

It means "By the deficiency" this sutra is used to calculate the square of the numbers using the deficiency of the number from the nearest numbers in powers of 10.

Numbers near and less than the bases of powers of 10.

Example 1: slove 8^2 (Here base is 10)
The answer is separated in to two parts.
Note that deficiency is 10 - 8 = 2
Multiply the deficit by itself or square it 2^2= 4.
As the deficiency is 1, subtract it from the number i.e., 8−2 = 6.
Now put 8 on the left and 1 on the right side of the vertical line or slash
i.e., 6 / 4. Answer is 64.

Numbers near and less than the bases of powers of 100.

Example 2: 93^2 (Here base is 100)
Since deficit is 100-93=7 and square of 7 is 49 and the deficiency
subtracted from the number 96 gives 93 - 7 = 86, we get the answer
86 / 49, Thus 93^2= 8649.

Numbers near and less than the bases of powers of 1000.

Example 3: 994^2 (Base is 1000)
Deficit is 1000 - 994 = 006. Square of it is 36.
Deficiency subtracted from 994 gives 994 - 6 = 988
Answer is 988 / 036 [since base is 1000]

Thus 988036

11. Vyastisamanstih

It means "**Whole as a one and one as whole** " this sutra is used to find the part of any particles from the mixture. This sutra is like calculating the probability of getting particles from the mixture. The steps in calculating the part whole ratio of the contents from the mixture are…

Step 1 : Find the total count of particles present in the mixture and the components and the individual count of the particles

Step 2 : Divide in the count of particle from the total count in mixture and calculate the same for all the partials in the mixture ..

Example : A box contains 2 white balls, 4 red balls, 5 blue balls and 6 yellow balls.

Step 1: Total count of balls in the box is i.e. (2 + 4 + 5 + 6) = 17

Step 2: The part and whole ratio of white balls is 2 / 17

The part and whole ratio of red balls is 4 / 17

The part and Whole ratio of blue balls is 5 / 17

The part and whole ratio of yellow balls is6 / 17

12. Sesanyankena Charmena

It means "the remainders by the last digit ", this sutra is used to express fraction numbers in to decimal numbers up to required decimal places under the condition that numerator should be less than the denominator. The steps involved in calculation are …

Step 1: If so the multiply numerator by 10 and then divide by denominator, if remainder value is not equal 1, then again multiply remainder by 10 and divide that value by denominator and the process should repeat until remainder is equal to 1.

Step 2: Multiply the entire reminder with denominator respectively from step 1.

Step 3: Taking the last digits of the output from step 2 and written the output from top to bottom.

Example: Solve. 3/7
Step 1: Numerator is less than denominator. (3 x 10)/7 = 2
(2x10)/ 7=6
(6x10)/ 7=4
(4x10) /7=5
(5x10) /7=1
Step 2: Multiply all the remainder with denominator,
(2x7) =14
(6x7) = 42
(4x7) = 28
(5x7) = 35
(1x7) = 7

Step 3: the output is 0.42857.
Step 1: Check that the numerator should be less than the denominator

13. Sopaantyadvayamantyam

I means "The ultimate and Twice the penultimate " this another method used for the multiplication of two numbers where the multiplicand can be any number but the multiplier should be 12, then only this sutra is applicable. The steps involved in multiplication of two numbers are.

Step 1: Insert zero at first and last place pf the Multiplicand.

Step 2: Add the last digit with the second last digit multiplied by 2, and the same process is carried for all the digits in the multiplicand respectively.

Step 3: the resultant value are written from bottom to top.

Example 1: Multiply 274x 12.

Step 1 : The new Multiplicand is 02740.

Step 2: 0 +(2x 4) = 8

4 + (2 x 7) = 18

7 + (2 x 2) = 11

2 + (2 x 0) = 2

Step 3: The above results are written from bottom to top respectively 2/ 11/ 18/ 8, the result is calculated as (2 + 1)(1 + 1)(8) (8). Multiplication of 274 and 12 is 3288.

14. Ekanyunena purvena

It means "**By one less than the previous one**" This sutra is applicable when the multiplier is 9 or array of 9.
The steps involved in the multiplication of two numbers are.

When number of 9's in the multiplier is same as the number of digits inthe multiplicand.

Step 1: The number being multiplied by 9's is first reduced by 1.

Step 2:1he result from the previous step should be subtracted from the multipliers. which is the second part of the answer.

Example : Multiply 76 and 99

Step 1:76 – 1 = 75 which is the first part of the answer.

Step 2: Subtract the multiplier from 75 i.e., 99 – 75 = 24 which is the second part of the answer.

76 x 99 = 7524

15. GunitSamuccayah

It means the product of sum is equal to the sum of the product ".
This sutra is used to check whether the given equation is correct or not using the roots of the equation 16
The steps involved in this sutra are

Step 1: Equating the roots of the equation and the quadratic equation, then equate the roots and the quadratic equation with their co - efficient
Step 2: It both the values are the same then the quadratic equation and their roots are correct.

Example: Solve $X^2 + 7X + 10 = 0$. The roots of the quadratic equation are (X +2) and (X + 5)
Step 1: $(X + 2)(X + 5) = X^2 + 5X + 6$

Step 2: (1 + 2) (1 + 5) = (1 + 7 + 10)

18=18. It satisfies the condition so the given equation is correct.

16. Gunak Samuccayah

It means "the factors of the sum is equal to the sum of the factors" this sutra is same as Chalana Kalanbhyam, It is used to find the roots of quadratic equation using the formula.

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

The roots of the quadratic equation $anX^2 + Bx + C$is (X+d)(X+c).
According to the sutra, 2aX+b=(X+d) + (X+ c).
This sutra mainly used for the verification of factors with the given quadratic equation

Steps involved in this sutra are.

Step 1: Find the factors of the given quadratic equation
Step 2: Add the factors of the quadratic equation and that must he Equal to the 2aX+b,1s this condition satisfies then the founded roots are the roots of quadratic equation

Example: Solve $X^2+7X+12=0$,
From the given equation a=1. b=7, c=12

Step 1: The roots of quadratic equation are (X+3)(X+4).

Step 2: Check if 2aX+b=(X+d) (X+e)

(2 x 1) X + 7 = (X + 4) + (X + 3) this condition gets satisfied so the rootsof the equation are (X +2) and (X +3).

RESULT AND CONCLUSION

From the above discussion of Vedic mathematics sutras, for multiplication urdhva - triyagbhyam sutra is best in case of speed, area and power consumption when compared to the nikhilam navatasaraman sutra and other sutras which are applicable for multiplication. Nikhilam navatasaraman sutra is also best but it is having certain conditions for multiplication. It is the biggest drawback in this sutra. Gunaksamuecayah and puranapuranabhyam are used to find the roots of quadratic and cubic equation respectively. Sesankenacarmena is used for recurring decimal places. Anurupyesunyamanya and sankalanavyakalanabhyam is used to find the solution of the equation but in which anurupyesunyamanya is best in this to find the solution of the equation Paravartya yojayet and Nikhilam navatasaraman sutras are used for division and they are applicable when the divisor is less than power of 10 and the divisor is greater than power of ten respectively. Gunitasamuccayah sutra is used to find the roots of quadratic equation using calculus formula.

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