

Various Vedic Mathematic Techniques for Calculations

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Abstract

Vedic Mathematics is a collection of Techniques /Sutras to solve mathematical arithmetic's in easy and faster way. It consists of 16 sutras (formulae) and 13 sub-sutras (sub formulae) which can be used for problems involved in arithmetic, algebra, geometry, calculus, conics. Using regular mathematical steps, solving problems sometimes are complex and time consuming. But using Vedic mathematics General Techniques (applicable to all sets of give data) and specific Techniques (applicable to specific sets of given data), numerical Calculations can be done very fast.

Many Vedic sutras are used in multiplier unit of computer .It will give faster results, which is very much required in various applications like cryptographic algorithm, image processing applications. Traditional methods used for multiplication, division require more time as compared to Vedic methods.

KEYWORDS-Vedic Sutra, Cryptographic, Image processing.

I. Introduction

Ancient Indian Vedas contain Indian system of mathematics which was rediscovered in the early twentieth century. It includes vedic mathematical formulae which can be applied to various branches of mathematics. The conventional mathematical algorithms are simplified and also optimized by using vedic sutras. Trigonometry, plain and spherical geometry, conics, calculus are one of few areas where these vedic sutras can be applied efficiently, Multiplication, division are one of arithmetic operations which require heavy calculations. Traditional methods for doing these operations take a lot of processing time. These traditional, methods include array, booth, carry save, Wallace tree, etc.

II. Vedic Mathematics

Veda is a Sanskrit word which means 'Knowledge'. The word veda also refers to the sacred ancient Hindu literature, which is divided into four volumes. Vedas initially were passed from previous generation to next generation orally. Later they were transcribed in Sanskrit.

Vedas include information from many subject such as from religion, astronomy, architecture, mathematics, medicine etc. Vedic mathematics is not only a mathematical wonder but also it is logical. That's why vedic mathematics has such a degree of prominence which cannot be disapprove. Due to these characteristics, vedic mathematics has already crossed the boundaries of India and has become a leading topic of research abroad vedic mathematics deals with various mathematical operations.

The system of vedic mathematics is based on 16 sutras- formulas and 13 sub-sutras or corollaries.

Sutra	Meaning
1. Ekadhikina Purvena	-By one more than the previous one
2. Nikhilam Navatashcaramam pashtah	-All From 9 and last from 10
3. Urdhva – Tiryakbhyam	- Vertically and crosswise
4. Paraavartya Yojayet	- Transpose and adjust.
5. Shunyam Saamyassamuccaye	- when the sum is the same that sum is zero.
6. Anunepye Shunyamanyat	- It one is in ratio, the other is zero
7. Sankalana- Vyayakalanabhyam	- By addition and by subtraction.
8. Puranapurabyhum	- By the completion and non completion
9. Chalana-Kalanabyham	- Differences and Similarities.
10. Yaavadunam	- Whatever the extent of its deficiency
11. Vyashtisamanstih	- Part and whole
12. Shesanyankena Charamena	- The remainders by the Last digit
13. Sopaantyadvayamantyam	- The ultimate and twice the penultimate.
14. Ekanyunena Purvena	- By one less then the previous one
15. Guntiasamuchyah	- The product of the sum is equal to the sum
16. Gunakasamuchyah	- The factor of sum is equal to the sum

The 13 Subsutras are described as below:

- 1- Anurupyena
- 2- Shishyate sheshsamjnah.
- 3- Adyamadyc Nantyamantyena
- 4- Kevalaih Saptakam Gonyat
- 5- Vestanam
- 6- Yavadunam Tavadunam Gonyat
- 7- Yavadunam Tavadunikutya Vargankach Yojayet
- 8- Antyayordhshakepi
- 9- Antyatoreva
- 10- Samucchayagunitah
- 11- Lopanasthapanabhyam
- 12- Vilokanam
- 13- Gunitasamuchyah samucchaya gunitah

III Multiplication Techniques/ Shortcut using vedic mathematics

Nikhilam Sutra literally means “All from 9 and last from 10”. This technique is applicable to all the cases of multiplication but it is more efficient in case of multiplication of large numbers. In this method, the compliment of the large numbers is found from its nearest base to perform the multiplication operation on it, hence large the original number, lesser the complexity of the multiplication.

Let us understand this technique with the help of example. If we want to multiply two numbers i.e. 962×998 it can be done as following table.

- 1- Both the numbers are closer to 10 power (base 1000)
- 2- 996 is 4 less than 1000 & 998 is 2 less than 1000.
- 3- $(-4) \times (-2) = 8$ (since base is 1000, use 008)
- 4- $996-2$ or $998-4 = 994$
- 5- Final answer 994008

$$\begin{array}{r} 996 - 4 \\ \times 998 - 2 \\ \hline 994/008 \\ =994008 \end{array}$$

Example 2.

- 1- Both the numbers are closer to 10 power (base 100)
- 2- 103 is 3 more than 100 & 108 is 8 more than 100.
- 3- $(+3) \times (+8) = 24$
- 4- $103 + 8$ or $108 + 3 = 111$
- 5- Final Answer : 11124

$$\begin{array}{r} 103 + 3 \\ \times 108 + 8 \\ \hline 111/24 \\ =11124 \end{array}$$

Anurupyena sutra:

This is a sub-type of Nikhilam Sutra and another Vedic maths multiplication trick when numbers are not closer to power of 10 but are closer to themselves. It works on concept of working base and then apply Nikhilam Sutra.

For Example: Multiplication of Numbers like 63 & 67

Process:

- 1- Working Base (W.B) Concept : as the number (63 & 67) are closer to 60, we take working base as 60 (60×10) Instead of 100 here factor is 6.
- 2- Apply concept of Nikhilam as discussed previously i.e 63 is 3 greater than 60 and 67 is 7 greater than 60.
- 3- Multiply 3 and 7 to get 21 in 2nd compartment. As base is $\times 10$, thus we need to have only 1 digit in 2nd compartment and hence need to carry forward 2 to 1st compartment.
- 4- Like Nikhilam sutras, cross addition of 63&7 or 67&3 gives 70.
- 5- In Anurupyens sutra, before adding carry forward directly to 1st compartment we need to multiply by the factor (6) and then add the carry forward, This carry forward (2) is added to 420
6. Final answer – 4221

$$\begin{array}{r}
 1. \quad 63 \times 67 \\
 WB = 10 \times 6 = 60 \\
 \begin{array}{r}
 63 \quad + 3 \\
 \times 67 \quad + 7 \\
 \hline
 70 \quad / \quad 21 \\
 \times \quad 6 \\
 \hline
 420 \quad / \quad 21 \\
 = 4221
 \end{array}
 \end{array}$$

$$\begin{array}{r}
 2. \quad 63 \times 67 \\
 WB = 10 \times 7 = 70 \\
 \begin{array}{r}
 63 \quad - 7 \\
 \times 67 \quad - 3 \\
 \hline
 60 \quad / \quad 21 \\
 \times \quad 7 \\
 \hline
 420 \quad / \quad 21 \\
 = 4221
 \end{array}
 \end{array}$$

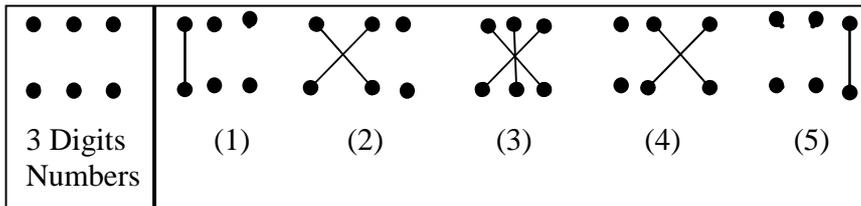
Urdhva Tiryak Sutra:-

This is another great shortcut method of multiplication using Vedic Mathematics, It can be applied very easily to multiply 3 digit numbers, multiply 4 digit numbers and even more than 4 digits numbers.

Let see an example multiplication of 3 digit numbers.

Formula used $(ax^2 + bx + c)(dx^2 + ex + f) = adx^4 + (ae + bd)x^3 + (af + bc + cd)x^2 + (bf + ce)x + cf$

Process : (Left → Right)



1. Vertical multiplication of Ist digits of 2 numbers.
2. Crosswise multiplication of Ist 2 digits and adding them.
3. Crosswise multiplication addition of all 3 digits of both the numbers.
4. Crosswise multiplication addition of last 2 digits 2 numbers.
5. Vertical multiplication of last digits 2 numbers.
6. For all steps, except Ist step, each compartment needs to have only 1 digits

If not then carry forward initial digits to previous compartment for example

$$\begin{array}{r}
 166 \\
 \times 232 \\
 \hline
 1 \times 2 / 1 \times 3 + 6 \times 2 / 1 \times 2 + 6 \times 3 + 6 \times 2 / 6 \times 2 + 6 \times 3 / 6 \times 2 \\
 = 2 / 15 / 32 / 30 / 12 \\
 \hline
 = 38512
 \end{array}$$

Antyaordasaka’pi

This sutra has another great multiplication trick in vedic mathematics which can be applied when last digits of both numbers totals as 10.

Steps:

1. Check if addition of last digits of the numbers 10.
2. If yes. Multiply then and write in 2nd compartment.
3. Add 1 to the remaining digits.

For example

$$\begin{array}{l}
 34 \times 36 \\
 = 3 \times 4 / 4 \times 6 \\
 = 12 / 24 \\
 = 1224
 \end{array}$$

$$\begin{array}{l}
 83 \times 87 \\
 = 8 \times 9 / 3 \times 7 \\
 = 72 / 21 \\
 = 7221
 \end{array}$$

IV. Division Techniques

Divide numbers in vedic mathematics in specific and general methods. Specific division method can be applied when numbers satisfy certain conditions like division slightly less than 100 or division slightly greater than power of 10 or divisor is ending with 9 etc. While general multiplication methods can be applied to any types of numbers.

Depending of divisor and dividend, Division in vedic mathematics are classified in the form of sutras as below.

1. Nikhilam sutra (Specific Technique)
2. Paravartya sutra (Specific Technique)
3. Anurupyena sutra (Specific Technique)
4. Direct flag method (General Technique)
5. Ekadhikena purvena (Specific Technique)
6. Vestanas (General Technique)

Nikhilam Sutra :-

This is vedic maths division method can be applied when divisor is closer to power of 10 but less than that of it.

Example: 243/9

$$\begin{array}{l}
 243/9 \\
 9/1 \quad 24 / 3 \\
 \underline{\quad 2 \quad 6} \\
 26/9 \\
 = 27/0 \\
 Q = 27 \\
 R = 0
 \end{array}$$

Process :-

1. 9 is 1 (deficiency) less than 10 (nearest power of 10). (That 1 is written in white color below divisor in Example)
2. Split dividend in 2 parts (Quotient & Remainder) in such a way remainder to have same number of digits as that of divisor. In this case its 1 digit.
3. Take 1st digit – 2 down as it is.

4. Multiply the above deficiency (1) with the 2 and put below 4 and add them column wise to get 6.
5. Multiply deficiency (1) by 6 and put below 3 and column wise to get 9.
6. As last column is filled we stop the process.
7. We know the concept the remainder can never be \geq divisor, as remainder 9 is = our divisor 9 .we divide 9 by 9 to get Quotient 1 and Remainder as 0.
8. Add the Quotient 1 to original quotient 26 to get 27.
9. Thus Quotient =27& remainder = 0.

Paravartya Sutra :-

This vedic maths Divison method can be applied when divisor is closer to power of 10 but greater than that of it.

Example :- 432/11

- Discard the Ist digit (1) of divisor (11) and take tanspose . of remaining digit (i.e - 1 or bar 1).
- Split dividend in 2 parts (Quotien & Remainder) in such a way that remainder part should have same number of digits thus obtained in Ist step. Thus remainder part will have only 1 digit.
- Now carry the same process as done with previous (Nikhilam Method).
- If any bar digit is present in final answer, convert to normal method using vinculum

$$\begin{array}{r}
 432 \div 11 \\
 11/-1 \text{ or } \bar{1} \quad 43/2 \\
 \quad \downarrow 4 \quad 1 \\
 \quad \underline{-41/3} \\
 \quad \quad = 39/3 \\
 \quad \quad \quad Q = 39 \\
 \quad \quad \quad R = 3
 \end{array}$$

Anurupyens Sutra:-

Anurupyena sutra is another specific vedic maths divison tricks which shows how to divide numbers when Nikhilam and Paravartya are not applicable. Using anurapyens sutra, we multiply division by a factor. So that either Nikhilam or Paravartya sutra can be applied.

Example:

- I. Divisor is 23. Multiply by factor (4) to ger 92 . So that Nikhilam Sutra of divison can be applies. As per Nikhlam Sutra,92 is 8 less than 100 (base). Hence write 08 under 92 (base is 100 so we need 2 digits)
- II. Apply Nikhilam Sutra.
- III. As per Anurupyen sutra, multiply by Quotient by the factor 4.
- IV. As we know the concept that Remainder can never be \geq Divisor as Remainder 91 is greater than our divisor 23. We divide 91 by 23 to get Quotient 3 and Remainder as 22.
- V. Add this Quotient 3 to original Quotient 40 to 43 as new Quotient.
- VI. Thus final answer,Quotient = 43 and Remainder =22

$$\begin{array}{r}
 1011 \div 23 \\
 23 \times 4 = 92 \\
 92/08 \quad \quad \quad 1011 \\
 \quad \quad \quad \quad \quad \downarrow 08 \quad 00 \\
 \quad \quad \quad \quad \quad \underline{10/91} \\
 \quad \quad \quad \quad \quad \quad \times 4 \\
 \quad \quad \quad \quad \quad \quad \underline{40/91} \\
 \quad \quad \quad \quad \quad \quad \quad = 43/22 \\
 \quad \quad \quad \quad \quad \quad \quad (91=3 \times 23+22) \\
 \quad \quad \quad \quad \quad \quad \quad \quad Q = 43
 \end{array}$$

Steps

- Divide 1 by 2 which gives Quotient as 0(Written with black) and remainder as 1 (written on left side of Quotient with Red)
- Now divide 10 by 2 which gives Quotient as 5 (Written with black) and remainder as 0(Written on left side of Quotient with Red)
- Now divide 05 by 2 which gives Quotient as 2 (Written with black) and Remainder as 1.(Written on left side of Quotient with Red)
- Similarly go on carrying this process till you find same pair of Quotient and Remainder is obtained.
- At the end we get 01, on dividing it by 2 we get Quotient as 0 and Remainder as 1. So that means same series will keep on repeating.
- So the series written in black colour is final answer. Ekadhikena Purvena can be applied to divisors ending with 8,7,1,2,3.

V CONCLUSION

In this paper, we focus different vedic mathematics techniques which are based on vedic mathematics sutras. Vedic mathematics sutras are used in place of different arithmetic operation like multiplication, division. They are useful in different application like digital signal processing, image processing and computation of heavy calculations. Vedic mathematics can definitely solve mathematical numerical calculations in very faster way. Using vedic maths tricks we can do calculations 10-15 times faster than our usual methods.

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