Shree H. N. Shukla Group of Colleges, Rajkot

BCA & B.Sc. (IT) Sem-01 (CS-07: Mathematics in Ancient India: Exploring the Rich Heritage of Vedic Mathematics)

Vedic Mathematics

Vedic Mathematics– Overview Contents

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What is Vedic Mathematics?

- **Vedic Mathematics** is a collection of Techniques/Sutras to solve mathematical arithmetics 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.
- Vedic Mathematics is a system of mathematics which was discovered by Indian mathematician **Jagadguru Sri Bharati Krishna Tirthaji** in the period between A.D. 1911 and 1918 and published his findings in a Vedic Mathematics Book by Tirthaji Maharaj.

What is Vedic Mathematics?

- Veda is a Sanskrit word which means ‘Knowledge’.
- Using regular mathematical steps, solving problems sometimes are complex and time consuming. But using Vedic Mathematic’s General Techniques (applicable to all sets of given data) and Specific Techniques (applicable to specific sets of given data), numerical calculations can be done very fast.

What are the Advantages of Vedic Mathematics?

- Vedic Mathematics can definitely solve mathematical numerical calculations in faster way.
- Some Vedic Math Scholars mentioned that Using Vedic Maths tricks you can do calculations 10-15 times faster than our usual methods.
- I agree this to some extent because some methods in Vedic Mathematics are really very fast. But some of this methods are dependent on the specific numbers which are to be calculated. They are called **specific methods**.

- More than 1700% times faster than normal Math: this makes it the World’s Fastest.
- Eradicates fear of Math completely. So If your child has Math-Phobia High Speed Vedic Math is a Fun-Filled way to do Math and arises interest in you and your child.
- Sharpens your mind, increases mental agility and intelligence.
- Increases your speed and accuracy. Become a Mental Calculator yourself.
- Improves memory and boosts self confidence.
- Cultivates an Interest in your for numbers.

A Little History

- **Shri Bharathi Krishna Tirthaji Maharaj** was born in March 1884 in the Puri village of Orissa state.
- He was very good in subjects like mathematics, science, humanities and was excellent in Sanskrit language.
- His interests were also in spiritualism and mediation. In fact when he was practicing meditation in the forest near Sringeri, he rediscovered the Vedic sutras.
- He claims that these sutras/techniques he learnt from the Vedas especially ‘Rig-Veda’ directly or indirectly and he intuitively rediscovered them when he was practicing meditation for 8 years.

Jagadguru Swami Sri Bharati Krsna Tirthaji Maharaja

- Born in 1884 to an educated and pious family
- Received top marks in school
- Sat for the M.A. exam of the American College of Sciences (Rochester NY) in Sanskrit, Philosophy, English, Mathematics, History and Science.

Jagadguru Swami Sri Bharati Krsna Tirthaji Maharaja

- Wrote sixteen volumes based on sixteen Sutras written 1911-1918.
- Volumes were unaccountably lost without a trace.
- Later he wrote the sutras on the manuscripts but were lost. Finally in year 1957, he wrote introductory volume of 16 sutras which is called as Vedic Mathematics and planned to write other sutras later. But soon he developed cataract in both of his eyes and passed away in year 1960.

The Sixteen Sutras

	Sutra	Translation
1)	एकाधिकेन पूर्वेण Ekādhikena Pūrveṇa	By one more than the one before
2)	निखिलं नवतश्चरमं दशतः Nikhilaṃ Navataścaramaṃ Daśataḥ	All from 9 and the last from 10
3)	ऊर्ध्वतिर्यग्भ्यामं Ūrdhva Tiryagbhyāṃ	Vertically and Crosswise
4)	परावर्त्य योजयेत् Parāvartya Yojayet	Transpose and Apply

The Sixteen Sutras

	Sutra	Translation
5)	शून्यं साम्यसमुच्चये Śūnyaṃ Sāmyasamuccaye	If the Samuccaya is the Same it is Zero
6)	आनुरूप्ये शून्यं अन्यत् Ānurūpye Śūnayamanyat	If One is in Ratio the Other is Zero
7)	संकलन व्यवकलनाभ्यां Saṅkalana Vyavakalanābhyāṃ	By Addition and by Subtraction
8)	पूरणापूरणाभ्यां Pūraṇāpūraṇābhyāṃ	By the Completion or Non-Completion

The Sixteen Sutras

Sutra		Translation
09)	चलनकलनाभ्याम् Calana Kalanābhyām̥	Differential Calculus
10)	यावदूनं Yāvadūnam̥	By the Deficiency
11)	व्यष्टिसमष्टिः Vyaṣṭisamaṣṭiḥ	Specific and General
12)	शेषाण्यङ्केन चरमेण Śeṣāṇyaṅkena Carameṇa	The Remainders by the Last Digit

The Sixteen Sutras

	Sutra	Translation
13)	सोपान्त्यद्वयमन्त्यं Sopāntyadvayamantyaṃ	The Ultimate and Twice the Penultimate
14)	एकन्यूनेन पूर्वेण Ekanyūnena Pūrvena	By One Less than the One Before
15)	गुणितसमुच्चयः Guṇitasamuccayaḥ	The Product of the Sum
16)	गुणकसमुच्चयः Guṇakasamuccayaḥ	All the Multipliers

1. Breaking the number:
1.1 Addition in mind

- Place Value

$33 = 3 \times 10 + 3 \times 1$

$562 = 5 \times 100 + 6 \times 10 + 2 \times 1$

$5149 = 5 \times 1000 + 1 \times 100 + 4 \times 10 + 9 \times 1$

$10120 = 1 \times 10000 + 0 \times 1000 + 1 \times 100 + 2 \times 10 + 0 \times 1$

1.2 Double/Triple in Mind

- Example of double/Triple in Mind

$$\begin{array}{r} 66 \\ +\underline{55} \\ 121 \end{array} \qquad \begin{array}{r} 29 \\ +\underline{74} \\ 103 \end{array} \qquad \begin{array}{r} 88 \\ +\underline{44} \\ 132 \end{array}$$

1.2 Double/Triple in Mind

- Example of double/Triple in Mind

$$
\begin{array}{rcl}
66 & = & 6 \times 10 + 6 \times 1 \\
+\ \underline{55} & = & \underline{5 \times 10} + \underline{5 \times 1} \\
121 & & 110 \quad + \quad 11
\end{array}
$$

$$1+1$$

$$1 \qquad 2 \qquad 1$$

1.2 Double/Triple in Mind

- Example of double/Triple in Mind

$$
\begin{array}{rcccccc}
366 & = & 3 \times 100 & + & 6 \times 10 & + & 6 \times 1 \\
+\ 4\underline{55} & = & \underline{4 \times 100} & + & \underline{5 \times 10} & + & \underline{5 \times 1} \\
821 & & 700 & + & 110 & + & 11
\end{array}
$$

$$7+1 \qquad\qquad 1+1$$

$$8 \qquad\qquad 2 \quad 1$$

3. Multiplication with a Series of 1's: 3.1 Multiplication by 11

- Example: 23×11

- Step 1 : Write the digit on L.H.S. of the number first. Here the number is 23 so, 2 is written first.

- Step 2 : Add the two digits of the given number and write it in between. Here $2 + 3 = 5$

- Step 3 : Now write the second digit on extreme right. Here the digit is 3. So, $23 \times 11 = 253$

3.1 Multiplication by 11

OR

$$23 \times 11 = 2 \ / \ 2+3 \ / \ 3 = 253$$

(Here base is 10 so only 2 digits can be added at a time)

3.1 Multiplication by 11

- Example 2: 243×11

- Step 1: Mark the first, second and last digit of given number

  First digit = 2, second digit = 4, last digit = 3

  Now first and last digits of the number 243 form the first and last digits of the answer.

- Step 2: For second digit (from left) add first two digits of the number i.e. $2 + 4 = 6$

3.1 Multiplication by 11

- Step 3: For third digit add second and last digits of the number i.e. $3 + 4 = 7$

$$\text{So, } 243 \times 11 = 2673$$

OR

$$243 \times 11 = 2 \;/\; 2 + 4 \;/\; 4 + 3 \;/\; 3 = 2673$$

Similarly we can multiply any bigger number by 11 easily.

3.1 Multiplication by 11

- Example 3: 42431×11

$42431 \times 11 = 4 \ / \ 4 + 2 \ / \ 2 + 4 \ / \ 4 + 3 \ / \ 3 + 1 \ / \ 1$

$= 466741$

3.2 Multiplication by 111

- Example: 189×111

- Step 1: Mark the first, second and last digit of given number

  First digit = 1, second digit = 8, last digit = 9

  Now first and last digits of the number 189 may form the first and last digits of the answer

- Step 2: For second digit (from left) add first two digits of the number i.e. $1 + 8 = 9$

3.2 Multiplication by 111

- Step 3: For third digit add first, second and last digits of the number to get $1 + 8 + 9 = 18$

(multiplying by 111, so three digits are added at a time)

- Step 4: For fourth digit from left add second and last digit to get, $8 + 9 = 1$

As we cannot have two digits at one place so 1 is shifted and added to the next digit so as to get

$$189 \times 111 = 20979$$

3.2 Multiplication by 111

OR

- Example: 189×111

1	$1 + 8 = 9$	$1 + 8 + 9$	$8 + 9$	9
	$9 + 1 =$	$= 18$	$= 1 \quad 7$	
$1 + 1 = 2$	$= 1 \quad 0$	$= 18 + 1$		
		$= 1 \quad 9$		

$\therefore 189 \times 111 = 20979$

3.2 Multiplication by 111

- Example : 2891×111

2	2 + 8	2 + 8 + 9	8 + 9 + 1	9 + 1
10 +	2 = 1	9 + 1 18	+ 1 = 1	0 1
	= 1 2	= 2 0	= 1 9	

$2891 \times 111 = 320901$

4. Multiplication by Criss-Cross Method (Urdhva- Triyagbyham)

- **Sutra: Vertically and cross-wise.**

Till now we have learned various methods of multiplication but these are all special cases, where numbers should satisfy certain conditions like near base, or sub base, complimentary to each other etc. Now we are going to learn about a general method of multiplication, by which we can multiply any two numbers in a line. Vertically and cross-wise sutra can be used for multiplying any number.

4.1 Two digit – multiplication

- Example: Multiply 21 and 23

- Step1: Vertical (one at a time)

$$\begin{array}{r} 2\,[1] \\ 2\,[3] \\ \hline \end{array} \quad \downarrow \; 1 \times 3 = 3 \qquad\qquad \begin{array}{c|c} & 3 \\ \hline & \end{array}$$

- Step2: Cross -wise (two at a time)

$$\begin{array}{ccc} 2 & & 1 \\ & \times & \\ 2 & & 3 \end{array} \qquad\qquad (2 \times 3 + 2 \times 1) = 8$$

$$\begin{array}{c|c|c} & 8 & 3 \\ \hline & & \end{array}$$

4.1 Two digit - multiplication

- Step3: Vertical (one at a time)

$$\begin{array}{cc} [2] & 1 \\ [2] & 3 \\ \hline \end{array} \qquad 2 \times 2 = 4 \qquad 4 \,/\, 8 \,/\, 3$$

Therefore, $21 \times 23 = 483$

4.1 Two digit – multiplication

- Example: Multiply 42 and 26

- Step1: Vertical (one at a time)

$$\begin{array}{r} 42 \\ \underline{26} \end{array} \downarrow \qquad 2 \times 6 = 12 \qquad / \, / \, 12$$

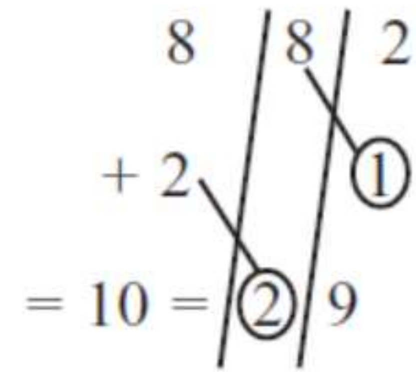
- Step2: Cross -wise (two at a time)

$$\begin{array}{ccc} 4 & & 2 \\ & \times & \\ 2 & & 6 \end{array} \qquad \begin{array}{c} 4 \times 6 + 2 \times 2 \\ 24 + 4 = 28 \end{array} \qquad / \, 2_8 \, / \, {}_1 2$$

4.1 Two digit – multiplication

- Step3: Vertical (one at a time)

$$\begin{array}{r} 42 \\ \underline{26} \end{array} \qquad 4 \times 2 = 8$$

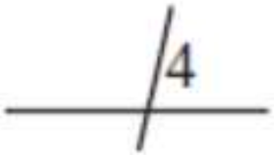


Therefore, $42 \times 26 = 1092$

4.2 Three digit – multiplication

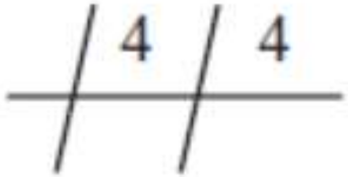
- Example: Multiply 212 and 112
- Step1: Vertical (one at a time)

$$\begin{array}{r} 212 \\ \underline{112} \end{array} \downarrow \qquad \begin{array}{l} 2 \times 2 \\ = 4 \end{array}$$



- Step2: Cross-wise (two at a time)

$$\begin{array}{ccc} 2 & 1 & 2 \\ \underline{1} & \underline{1} & \underline{2} \end{array} \qquad \begin{array}{l} 2 \times 1 + 2 \times 1 \\ = 2 + 2 = 4 \end{array}$$



4.2 Three digit - multiplication

- Step3: Vertical and cross-wise (three at a time)

$$\begin{array}{ccc} 2 & 1 & 2 \\ 1 & 1 & 2 \end{array}$$

$$2 \times 2 + 2 \times 1 + 1 \times 1 = 4 + 2 + 1 = 7$$

$$/7/4/4$$

- Step4: cross wise (Two at a time)

$$\begin{array}{ccc} 2 & 1 & 2 \\ \underline{1} & \underline{1} & \underline{2} \end{array} \quad \begin{array}{l} 2 \times 1 + 1 \times 1 \\ = 2 + 1 = 3 \end{array}$$

$$/3/7/4/4$$

4.2 Three digit – multiplication

- Step5: vertical (one at a time)

$$\begin{array}{r} 2\,1\,2 \\ \underline{1\,1\,2} \end{array} \qquad 2 \times 1 = 2$$

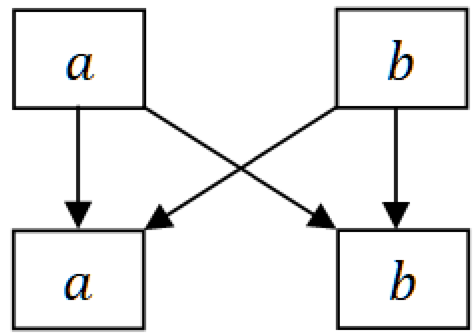
$$2 \,/\, 3 \,/\, 7 \,/\, 4 \,/\, 4$$

Therefore, $212 \times 112 = 23744$

5. Squaring
5.1 Square of Two Digit Number

- Example: $(ab)^2$

For $(ab)^2$, you write the number below each other:



$$\boxed{a \times a / a \times b + a \times b \ / \ b \times b}$$

VERTICAL / CROSS / VERTICAL

The number are written left to right.

5.1 Square of Two Digit Number

- Multiply:

1) Vertically $\longrightarrow (a \times a)$
2) Crosswise in both directions and add $\longrightarrow (a/a \times b + a \times b)$
3) Vertically $\longrightarrow (b \times b)$

The answer of the form:

$$a \times a/a \times b + a \times b \;/\; b \times b$$

5.1 Square of Two Digit Number

- Example: $(13)^2$

$$\begin{array}{ccc} 1 & & 3 \\ 1 & & 3 \\ \hline 1/ & 3+3 & /9 \\ 1/ & 6 & /9 \end{array}$$

Therefore, $(13)^2 = 169$

5.1 Square of Two Digit Number

- Example: $(63)^2$

$$\begin{array}{ccc} & 6 & 3 \\ & 6 & 3 \\ \hline 36/ & 6\times 3+6\times 3 & /\,9 \end{array}$$

$$36\,/\quad 36\quad /\,9$$

$$36\,/\quad {}_{3}6\quad /\,9$$

Carry over the 3:

$$36+3\,/\quad 6\quad /\,9$$

$$39\,/\quad 6\quad /\,9$$

Therefore $(63)^2 = 3969$

5.3 Number Ends With 5

- Example: 25^2

Here the number is 25. We have to find out the square of the number. For the number 25, the last digit is 5 and the 'previous' digit is 2. Hence, 'one more than the previous one', that is, 2+1=3. The sutra, in this context, gives the procedure **'to multiply the previous digit 2 by one more than it self, that is by 3'**. It becomes L.H.S. (left hand side) of the result, that is,

$$2 \times 3 = 6$$

The R.H.S. (right hand side) of the result is 5^2, that is, 25.

5.3 Square of Number Ends With 5

Thus $25^2 = 2 \times 3/25 = 625$

In this way,

$35^2 = 3 \times 4/25 = 1225$

$65^2 = 6 \times 7/25 = 4225$

$105^2 = 10 \times 11/25 = 11025$

$135^2 = 13 \times 14/25 = 18225$

$1225 = 122 \times 123/25 = 1500625$

THANK YOU