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Vedic mathematics in derivatives and integration, differential equations and partial differential equations

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Abstract
Vedic Mathematics which depends on Sūtras and Sub-Sūtras the type of word formulae written in Sanskrit. The scientist's goal is to discover the Contribution of Vedic Mathematics in Advance Calculus. To break down the uses of Vedic mathematics Sūtras determinants, matrices, and discovering determinants of different networks and conditions. The age of the student and capabilities don't represent an issue in this cycle and very little exertion is needed to break the reliance on mini-computers. To put it plainly, Vedic Mathematics is a guide to improve computation ability. Researcher has reasoned that the main element of Vedic mathematics is its consistency. In view of this quality, it makes mathematics simple and charming. It additionally rouses developments.

Keywords: Vedic, mathematics, sūtras, matrices, determinants

Introduction
The principle point of showing mathematics in schools is to foster logical mentality towards Mathematics. Presently a-days Mathematics is being a mandatory subject of essential and auxiliary school understudies. Mathematics is considered by numerous students as a dry subject. Each kid's right is to get quality mathematics schooling. So it is the obligation of the instructors to give mathematics training to be simple, pleasant and furthermore reasonable to each youngster. The mother of all sciences is mathematics. It is vital in everybody's life. Without the utilization of mathematics, it is undeniably challenging to get by throughout everyday life. Everybody utilizes mathematics in one or alternate manner in his/her day by day life. We can't envision an existence without mathematics. From transient to money manager, everybody utilizes mathematics in their life. A large portion of the issues in Mathematics have sorcery and secrets. Our people of old saw this load of secrets and fostered some straightforward ways/strategies to take care of mathematical issues. Numerous years prior our Indians utilized a few procedures in different fields like development of sanctuaries, medication, science, soothsaying, and so forth, because of which, we can gladly say that India created as the most extravagant country on the planet.

Introduction to differential calculus:
The development of both the Differential Calculus and the Integral Calculus is the most significant mathematical achievement. For a wide variety of real-life applications which require us to find the rate of change of one parameter with respect to another for Differential Calculus plays an important role.
For any function at a given point, you can find its derivative geometrically by drawing an angle at that point, then evaluating the slope. If y = f(x) given then

$$\frac{dy}{dx} = f'(x)$$

By using Dhvaja Ghata (power)
The method to find first differential of the each term of the quadratic expression ax2 + b x + c, is by multiplying its DhvajaGhata (power) by the Anka (its coefficient) and educing by one.

Example 1:
Find derivative of quadratic expression x2 - 9x + 14

Let E = x2-9x + 14.

As per current method, taking derivative of y w.r.t. x

$$\frac{dy}{dx} = f'(x) = \frac{d}{dx}(x^2) - 9\,\frac{d}{dx}(x) + \frac{d}{dx}(14)$$

= 2x – 9(1) + 0

$\frac{dy}{dx}$ =2=2x – 9

By using Dhvaja Ghata, Finding first differential of each term of quadratic expression x2 - 9x + 14,
x2 gives 2x; - 9x gives - 9 and 14 gives zero.

Therefore

D1 = f $\frac{d}{dx}$ (x^2-9x + 14) = 2x - 9.

Calana-Kalanābhyām Sūtra: Meaning
Differential Calculus Discriminant of the quadratic first differential and square root of Discriminant are shown in this Sūtra. ŚRĪ BHĀRATĪ KRA known this Sūtra was the Calculus formula for finding the two roots of a quadratic equation that was given. First differential, he argues, is equal to the square root of original quadratic equation's discriminant. Thus, roots of given quadratic equations are obtained by solving two simple equations.

Example 2:
Solve the quadratic equation x2 – x - 12 = 0
The first differential D1 = 2x - 1 and
The square root of the discriminant is ± √1 + 48 = ± √49 = ±7
As per above rule, D1 =± √Discriminant ∴ 2x - 1 = ±7
Thus the given equation is broken down into two simple equations

∴ 2x - 1 = ±7

∴ 2x = ±7 + 1

∴ x = 4 OR x = −3

Vertically & crosswise sūtra in solving successive differentiation
Derivative of multiplication of 2 functions by Crosswise Sūtra
Let u & w both be in the form of variable x, and if y = u. w then

$$\frac{dy}{dx} = u.\frac{dw}{dx} + w.\frac{du}{dx} \dots\dots [P]$$

Differentiation of multiplication of such type of a relationship is found out using Vedic Crosswise Sūtra, if one knows standard formula.

Example 3:

Find $\frac{dy}{dx}$ $\boldsymbol{if\ y = x^2.2^x}$

By current method, By using above formula [P],

u = x^2& w = 2^x;

By Vedic Method
Applying standard formula for finding derivative of u and w, By using Vedic Crosswise Sūtra

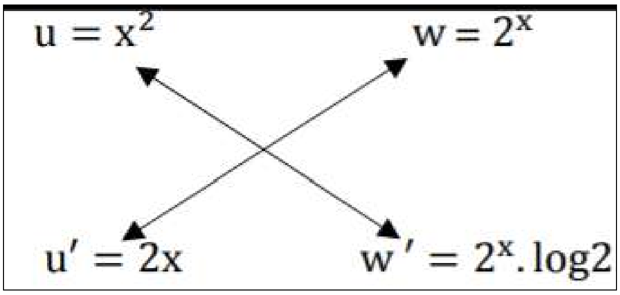

Fig 1: From the above figure,

Example 4:

$$\therefore \frac{dy}{dx} = x^2(2^x \log 2) + 2x(2^x$$

By using current method,

$u = (2x^2 + 3x + 7)$ w $= (5x^2 + 7)$

$$\boldsymbol{\frac{dy}{dx} \; if \; y = (2x^2 + 3x + 7)(5x^2 + 7)}$$

$$u' = \frac{du}{dx} = 4x + 3 \quad \& \quad w' = \frac{dv}{dx} = 10x$$

$$\therefore \frac{dy}{dx} = (2x^2 + 3x + 7)10x + (5x^2 + 7)(4x + 3) \qquad \because \text{from}[P]$$

By using Vedic Method
By using DhvajaGhata,

$$u' = \frac{du}{dx} = \frac{d}{dx}(2x^2 + 3x + 7) \;\therefore u' = 4x + 3 \;\&\; w' = \frac{dw}{dx} = \frac{d}{dx}(5x^2 + 7) \quad \therefore w' = 10x$$

By using Vedic Crosswise Sūtra

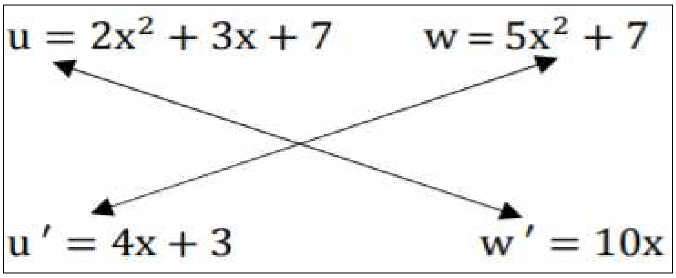

Fig 2:

$$\therefore \frac{dy}{dx} = (2x^2 + 3x + 7)10x + (5x^2 + 7)(4x + 3)$$

Digression: Differentiation of the ratio of the polynomials
Derivative of the division of two polynomials
If u and w both are polynomials then by using Vertically & Crosswise Sūtra derivative of division of two polynomial functions can be easily find out.

Example 5:
Differentiate

$$y = \frac{2 + 4x}{2x + 2x^2}$$

By applying division rule,

$$\frac{dy}{dx} = \frac{(2x + 2x^2)4 - (2 + 4x)(2 + 4x)}{[2x + 2x^2]^2}$$

$$= \frac{(8x + 8x^2) - (4 + 16x + 16x^2)}{[2x + 2x^2]^2}$$

$$= \frac{8x + 8x^2 - 4 - 16x - 16x^2}{[2x + 2x^2]^2}$$

$$\therefore \frac{dy}{dx} = \frac{-4 - 8x - 8x^2}{[2x + 2x^2]^2}$$

For finding the derivative of division of two polynomials by using crosswise division, the method described above is quite lengthy sūtra this answer's numerator can be easily found by referring to the figure below, while the denominator is the square of the term in the denominator.

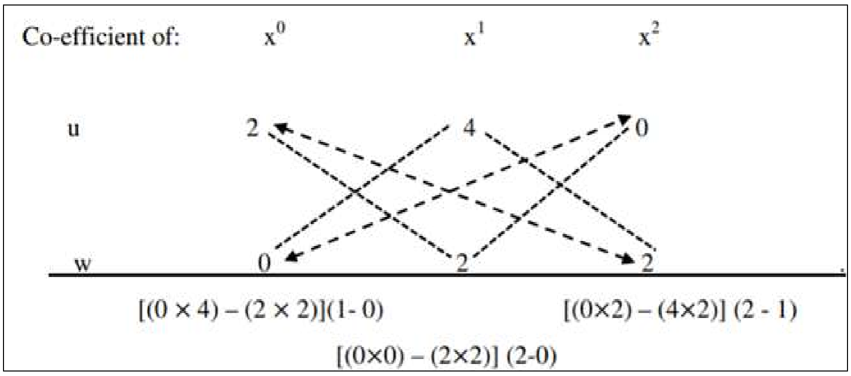

Fig 3:

$$\text{Let } y = \frac{2 + 4x}{2x + 2x^2} = \frac{2x^0 + 4x + 0x^2}{0x^0 + 2x + 2x^2}$$

$$\frac{dy}{dx} = \frac{(0 \times 4 - 2 \times 2)(1 - 0) + (0 - 2 \times 2)(2 - 0)x + (2 \times 0 - 4 \times 2)(2 - 1)x^2}{[2x + 2x^2]^2}$$

$$= \frac{(-4) + (-4)2x + (-8)x^2}{[2x + 2x^2]^2}$$

$$\therefore \frac{dy}{dx} = \frac{-4 - 8x - 8x^2}{[2x + 2x^2]^2}$$

Integration based on partial fraction by parāvartya yojayet sūtra

If f(x) and h(x) are two polynomials, is an entirely new relationship between two polynomials, whose rationality depends on the range of values its denominator can take, h(x) having a non-zero value, the function is rational, and its degree exceeds f(x), making it proper. Using the following table where L, M, N, and O are real numbers, it can be expressed as partial fractions.

Table 1:

Rational Form	Partial Form
$\frac{Px^2 + qx + r}{(x - a)(x - b)(x - c)}$	$\frac{L}{(x - a)} + \frac{M}{(x - b)} + \frac{N}{(x - c)}$
$\frac{Px^2 + qx + r}{(x - a)^2 (x - b)}$	$\frac{L}{(x - a)} + \frac{M}{(x - a)^2} + \frac{N}{(x - b)}$
$\frac{Px^2 + qx + r}{(x - a)^3 (x - b)}$	$\frac{L}{(x - a)} + \frac{M}{(x - a)^2} + \frac{N}{(x - a)^3} + \frac{O}{(x - b)}$

$\dfrac{Px^2 + qx + r}{(x - a)(x^2 + bx + c)}$	$\dfrac{L}{(x - a)} + \dfrac{Mx + N}{x^2 + bx + c}$ Where $x^2 + bx + c$ can't be factorized Integration Partial fraction is an important. Solving the problem of integration on partial fraction by using Parāvartya Yojayet Sūtra is easily than the current laborious method further.

Partial fractions mean decomposing the denominator into irreducible factors.

Integration by parts

The method of integration by parts is used when the integrand is expressed as a product of two functions, one of which can be differentiated (u) and the other can be integrated (w) conveniently. Let w and u are expressed in terms of variable.

$$\int u.w\,dx = u\int w dx - \int \left\{\frac{d}{dx}(u)\int w\,dx\right\} dx$$

It is important to choose first and second functions carefully when integrating a function that is the product of two functions, with the first function being differentiated and the second function being integrated (whose integral is known)..

We can also choose the first function as the function which comes first in the word 'LIATE' where L-logarithmic function I for Inverse, A-algebraic T-trigonometry And E-exponential

Integration of the product of two functions by vertically and crosswise

For the integration of the product of two functions (of x), can be solve by the following formula by multiplying it crosswise and add it with alternative sign.

$$\int u.w\,dx = uw' - u_1w'' + u_2w''' - u_3w'''' + u_4w''''' - \ldots\ldots\ldots\ldots$$

Example 6:

Find the following integrals

According to current method,

$$Let\ I = \int x^2 e^{2x} dx$$

u = x^2 and w = e^{2x} & by using integration by parts formula,

$$I = x^2 \int e^{2x}\,dx - \int \left(\frac{d}{dx}(x^2)\int e^{2x}\,dx\right) dx$$

$$= x^2 . \frac{e^{2x}}{2} - \int \left[(2x)\left(\frac{e^{2x}}{2}\right)\right] dx = \frac{x^2e^{2x}}{2} - \int x\,e^{2x}\,dx$$

Again by using integration by parts method for $\int x^2 e^{2x} dx$

$$= \frac{1}{2}x^2e^{2x} - \left[x\int e^{2x}dx - \int\left(\frac{d}{dx}(x)\int e^{2x}dx\right)dx\right]$$

$$= \frac{1}{2}x^2e^{2x} \left[x\int e^{2x}dx - \int\left[(1)\left(\frac{e^{2x}}{2}\right)\right]dx\right]$$

$$= \frac{1}{2}x^2e^{2x} - \left[\frac{1}{2}\,x\,e^{2x} - \frac{1}{2}\int e^{2x}\,dx\right]$$

$$= \frac{1}{2}x^2e^{2x} - \left[\frac{1}{2}\,x\,e^{2x} - \frac{1}{2}\left[\frac{e^{2x}}{2}\right]\right] + c$$

$$= \frac{1}{2}x^2e^{2x} - \left[\frac{1}{2}\,x\,e^{2x} - \frac{1}{4}\,e^{2x}\right] + c$$

$$\therefore I = \frac{1}{2} x^2 e^{2x} - \frac{1}{2} x e^{2x} + \frac{1}{4} e^{2x} + c$$

By using Vertically & Crosswise Sūtra:

Let $I = \int x^2 e^{2x} d$

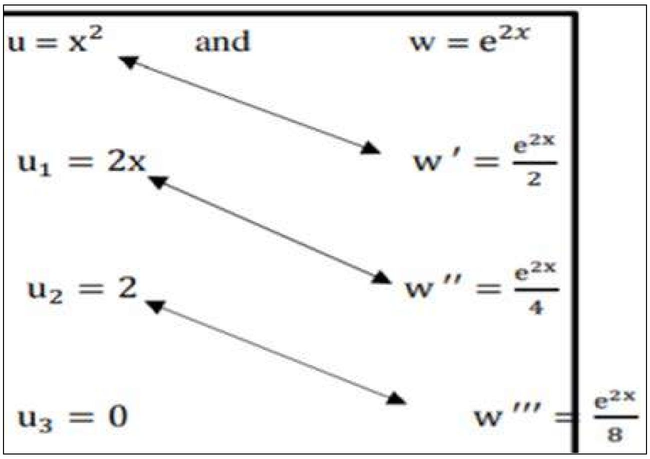

Fig 4:

By using equation [B]

$$\therefore \int x^2 e^{2x} dx = \frac{1}{2} x^2 e^{2x} - \frac{1}{2} x e^{2x} + \frac{1}{4} e^{2x} + c$$

Conclusion

By utilizing Vedic Sūtras convoluted and extensive calculations can be tackled with more prominent exactness and lesser time when contrasted with estimations dependent on ordinary maths. VM likewise further develops memory and makes more noteworthy mental sharpness. The main nature of Vedic Maths is its consistency. In light of this quality, it establishes tranquil and agreeable climate. It motivates advancements. The delightful rationality among number-crunching and polynomial math is unmistakably apparent in the Vedic system. Vedic calculations dependent on Ūrdhva-Tiryagbhyām Sūtra, Nikhila Sūtra ṁ and Ānurūpye a Sub-ṇ Sūtra and so on can be applied to plan extraordinary speed Vedic Multipliers and reconfigurable Fast Fourier Transform (FFT) in DSP.

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