



Exploring the Relationship between Vedic Mathematics and Advanced Calculus

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ABSTRACT

The relationship between Vedic Mathematics and Advanced Calculus can be seen as a bridge between practicality and abstraction in the realm of mathematics. Vedic Mathematics, rooted in ancient Indian texts, emphasizes intuitive and mental calculation techniques for various mathematical operations. On the other hand, Advanced Calculus deals with complex mathematical concepts and techniques, focusing on abstract ideas like limits, derivatives, integrals, and infinite series. Despite their apparent differences, these two disciplines share common objectives and can complement each other in several ways. Both Vedic Mathematics and Advanced Calculus strive for algorithmic efficiency in solving mathematical problems. Vedic Mathematics offers quick and efficient methods for mental calculations, while Advanced Calculus develops advanced techniques for tackling intricate mathematical challenges. By combining these approaches, students can enhance their computational speed and problem-solving abilities. Moreover, both Vedic Mathematics and Advanced Calculus provide distinct problem-solving techniques. Vedic Mathematics offers specific methods for multiplication, division, square roots, and equation solving, providing alternative approaches to traditional algorithms. Advanced Calculus, on the other hand, equips students with tools to solve complex problems in calculus, such as optimization, differential equations, and multivariable integration. Exploring the relationship between these disciplines allows students to broaden their problem-solving repertoire and approach mathematical challenges from different angles.

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INTRODUCTION

Vedic Mathematics and Advanced Calculus are two distinct mathematical systems that originated from different times and cultures. While Vedic Mathematics traces its roots to ancient Indian texts called the Vedas, Advanced Calculus is a branch of mathematics that developed in the Western world during the modern era.

Vedic Mathematics is a system of mathematical techniques and principles that were derived from ancient Indian scriptures known as the Vedas. These techniques were rediscovered and popularized by Sri Bharati Krishna Tirthaji Maharaja in the early 20th century. Vedic Mathematics emphasizes mental calculations and provides alternative methods for arithmetic, algebra, geometry,

and trigonometry. Its techniques are often based on simple principles, patterns, and sutras (aphorisms) that enable quick calculations.

On the other hand, Advanced Calculus is a branch of mathematics that deals with the study of limits, continuity, derivatives, integrals, and infinite series. It is an extension of elementary calculus and forms an essential foundation for various scientific disciplines, including physics, engineering, and economics. Advanced Calculus explores the properties and behavior of functions, and it provides powerful tools for analyzing complex systems and solving intricate mathematical problems. While Vedic Mathematics focuses on mental calculation techniques and provides shortcuts for performing arithmetic



operations, Advanced Calculus delves into the theoretical underpinnings of calculus and its applications in analyzing mathematical models and physical phenomena. Advanced Calculus involves rigorous proofs, mathematical reasoning, and abstract concepts that extend beyond the scope of Vedic Mathematics. Vedic Mathematics and Advanced Calculus differ in their origins, methodologies, and objectives. Vedic Mathematics emphasizes mental calculations and provides alternative techniques for basic mathematical operations, whereas Advanced Calculus is a branch of mathematics that focuses on the study of limits, derivatives, integrals, and their applications in mathematical analysis. While both systems contribute to mathematical knowledge, they serve different purposes and cater to different aspects of mathematical understanding.

Advantages Vedic Mathematics and Advanced Calculus

Vedic Mathematics and Advanced Calculus offer distinct advantages and benefits within the realm of mathematics and its applications. Here are some of the advantages of each system:

Advantages of Vedic Mathematics:

Speed and Efficiency: Vedic Mathematics techniques are known for their emphasis on mental calculations and shortcuts. These methods enable individuals to perform arithmetic operations quickly and efficiently, enhancing computational speed and accuracy.

Simplified Techniques: Vedic Mathematics provides simplified techniques for arithmetic, algebra, geometry, and trigonometry. These methods often involve patterns, sutras, and simple principles that allow for streamlined calculations and problem-solving.

Flexibility and Adaptability: Vedic Mathematics techniques offer alternative approaches to traditional mathematical methods. This flexibility allows individuals to choose the most suitable method for a particular problem, promoting adaptability and fostering creativity in mathematical thinking.

Enhances Mental Agility: Studying Vedic Mathematics can improve mental agility and cognitive skills. The practice of mental calculations, visualization of patterns, and utilization of specific techniques can enhance memory, concentration, and overall numerical proficiency.

Advantages of Advanced Calculus:

Rigorous Framework: Advanced Calculus provides a rigorous mathematical framework for the study of limits, derivatives, integrals, and infinite series. It offers a precise and formalized approach to analyzing functions and understanding their behavior.

Powerful Analytical Tools: Calculus techniques, such as derivatives and integrals, provide powerful tools for analyzing and solving complex mathematical problems. These tools are widely used in various scientific disciplines, engineering, economics, and other fields that require mathematical modeling and optimization.

Fundamental Basis for Higher-level Mathematics: Advanced Calculus serves as a foundational branch of mathematics that underpins higher-level mathematical concepts and theories. It is an essential prerequisite for studying fields such as differential equations, mathematical analysis, and advanced mathematical modeling.

Real-world Applications: The principles of Advanced Calculus find widespread applications in diverse fields, including physics, engineering, economics, computer science, and data analysis. They enable the understanding of rates of change, optimization of functions, and the modeling of real-world phenomena.

Vedic Mathematics and Advanced Calculus offer distinct advantages. Vedic Mathematics emphasizes speed, efficiency, mental agility, and alternative techniques, while Advanced Calculus provides a rigorous framework, powerful analytical tools, and widespread applications in various disciplines. Understanding and harnessing the strengths of both systems can contribute to a well-rounded mathematical skill set and enhance problem-solving abilities in different mathematical contexts.

NEED OF THE STUDY

Studying both Vedic Mathematics and Advanced Calculus can be valuable for different reasons. Here are some of the key reasons why the study of both these mathematical systems is beneficial:

Mental Calculation Efficiency: Vedic Mathematics techniques provide shortcuts and mental calculation methods that can significantly enhance one's speed and efficiency in performing arithmetic operations. These techniques can be particularly useful in situations where quick calculations are required, such as in competitive exams, day-to-day calculations, or problem-solving scenarios.

Alternative Approaches: Vedic Mathematics offers alternative approaches to traditional mathematical methods, allowing individuals to explore different ways of solving problems. This can promote creative thinking and problem-solving skills, as well as develop a deeper understanding of mathematical concepts through different perspectives.

Strong Foundation: Advanced Calculus, as a branch of mathematics, forms a foundational pillar for many scientific disciplines and advanced mathematical concepts. It provides a rigorous framework for understanding and analyzing functions, limits, derivatives, and integrals. Proficiency in Advanced Calculus is essential for pursuing higher-level mathematics, engineering, physics, economics, and other STEM fields.

Analytical and Critical Thinking: The study of Advanced Calculus helps develop analytical and critical thinking skills. It trains individuals to analyze problems, break them down into smaller components, and apply mathematical reasoning to arrive at solutions. These skills are invaluable for tackling complex real-world problems and formulating logical arguments.

Mathematical Modeling: Advanced Calculus plays a crucial role in mathematical modeling, where real-world phenomena are represented mathematically and analyzed using calculus techniques. By studying Advanced Calculus, individuals gain the ability to describe and predict the behavior of

systems, understand rates of change, optimize functions, and solve problems in various scientific and engineering domains.

While Vedic Mathematics and Advanced Calculus differ in their approaches and objectives, they both contribute to enhancing mathematical skills and understanding. Vedic Mathematics can improve mental calculation abilities and offer alternative methods, while Advanced Calculus provides a solid foundation for advanced mathematical concepts and analytical thinking. Together, they provide a diverse skill set that can be applied in various academic, professional, and practical scenarios.

SCOPE OF THE STUDY

The scope of the study of Vedic Mathematics in the context of advanced calculus is broad and can encompass several areas. The study can include the exploration of various Vedic Mathematics techniques and their application in advanced calculus topics such as differentiation, integration, differential equations, and partial differential equations. Moreover, the study can investigate the effectiveness of using Vedic Mathematics techniques in the classroom, including the impact on student engagement, motivation, and academic performance. It can also examine the challenges associated with the integration of Vedic Mathematics techniques into the curriculum and explore ways to overcome these challenges.

The scope of the study can also include the development of teaching resources and materials that incorporate Vedic Mathematics techniques in advanced calculus education. These materials can be used to enhance teaching and learning, and provide students with an opportunity to develop their problem-solving skills, mental calculation abilities, and pattern recognition skills. Additionally, the study can investigate the potential applications of Vedic Mathematics in other areas of mathematics and science, such as physics, chemistry, and engineering. This can include the development of mathematical models and simulations that utilize Vedic Mathematics techniques to solve complex problems. The scope of the study of Vedic

Mathematics in the context of advanced calculus is broad and can encompass several areas, including the exploration of various techniques, effectiveness in the classroom, development of teaching resources, and potential applications in other fields. The study has the potential to contribute to the development of innovative and effective teaching practices and expand our understanding of the application of Vedic Mathematics in mathematics and science.

Theoretical approaches.

In exploring the relationship between Vedic Mathematics and Advanced Calculus, the study may involve several theoretical approaches. Here are a few possible approaches that can be considered:

Comparative Analysis: This approach involves comparing the principles, techniques, and concepts used in Vedic Mathematics and Advanced Calculus. It would include analyzing the underlying mathematical foundations, methods of calculation, algorithms, and problem-solving approaches in both systems. This comparative analysis can help identify similarities, differences, and potential connections between the two.

Historical Perspective: Examining the historical development and evolution of Vedic Mathematics and Advanced Calculus can provide insights into their respective origins, influences, and contexts. This approach involves studying ancient mathematical texts, historical mathematical figures, and the cultural and societal factors that shaped these systems. It can shed light on the historical interactions and potential influences between Vedic Mathematics and the development of Calculus.

Mathematical Foundations: This approach focuses on the mathematical foundations of both Vedic Mathematics and Advanced Calculus. It involves studying the axiomatic systems, formal logic, and mathematical structures underlying each system. This approach can help identify the fundamental principles and concepts that form the basis of Vedic Mathematics and Advanced Calculus and explore any connections or overlaps between them.

Cognitive and Psychological Analysis: Understanding the cognitive and psychological aspects of mathematical thinking in both Vedic Mathematics and Advanced Calculus can provide insights into how individuals approach problem-solving and mathematical reasoning in these systems. This approach may involve studying cognitive processes, mental representations, and problem-solving strategies employed in both systems and exploring potential similarities or differences in these aspects.

Educational and Pedagogical Perspectives: This approach focuses on the implications of the relationship between Vedic Mathematics and Advanced Calculus for mathematics education and pedagogy. It involves considering how the insights gained from studying both systems can be integrated into teaching methods, curriculum design, and instructional materials. This approach may also include exploring the effectiveness of incorporating Vedic Mathematics principles or techniques into the teaching and learning of Advanced Calculus.

These theoretical approaches can be combined and adapted based on the specific research goals and objectives of the study. The aim is to provide a comprehensive understanding of the relationship between Vedic Mathematics and Advanced Calculus from different theoretical angles.

SIGNIFICANCE OF THE STUDY

The study of Vedic Mathematics in the context of advanced calculus has significant implications for both education and research. The study can contribute to the development of innovative teaching practices that enhance student engagement and motivation in mathematics education. The use of Vedic Mathematics techniques can offer a unique and interesting approach to problem-solving that can inspire students to take a more active role in their learning and develop a deeper understanding of the concepts. Moreover, the study can lead to the development of teaching resources and materials that incorporate Vedic Mathematics techniques into the curriculum, providing students with the opportunity to develop their problem-

solving skills, mental calculation abilities, and pattern recognition skills.

LITERATURE REVIEW

Agrawal Kajal et.al (2018)The connection between Vedic Mathematics and Advanced Calculus also encompasses the concept of mathematical abstraction. Vedic Mathematics, while practical in nature, often relies on visual and geometrical insights to simplify calculations. Advanced Calculus, with its emphasis on abstract concepts, provides a rigorous framework for modeling and understanding real-world phenomena. By studying both disciplines, students can develop a holistic understanding of mathematics, appreciating the power of abstraction in Advanced Calculus while benefiting from the practicality and visualization techniques offered by Vedic Mathematics.

DafeSuraj et.al, (2015) it's been attempted to find the thought of presence of calculus in Vedic and Post Vedic period. From sulva sutra of Vedic period, it's observed that Vedic Hindus had knowledge of integration as well as differentiation. Works of various Mathematicians of post Vedic period have been studied and eventually, we discover this calculus had presence in this particular period.

Deepshikha Bhargava & Anita Arya (2017)The historical and cultural context adds depth to the relationship between Vedic Mathematics and Advanced Calculus. Vedic Mathematics has its roots in ancient Indian mathematical traditions, reflecting the historical and cultural contributions of the Indian subcontinent to the field of mathematics. Advanced Calculus, on the other hand, represents the culmination of mathematical developments across various cultures and time periods. Exploring this relationship allows students to appreciate the historical evolution of mathematical ideas and the global nature of mathematical advancements.

Dhara R. Joshi (2017)This study aimed to investigate the application of Vedic Mathematics techniques in teaching algebraic expressions in middle school classrooms. The study used a mixed-methods approach,

combining quantitative and qualitative data collection and analysis methods. The participants in the study were middle school students from a public school in India. The results of the study indicate that the use of Vedic Mathematics techniques can enhance students' understanding and performance in algebraic expressions. The students who were exposed to Vedic Mathematics techniques showed significant improvement in their ability to solve algebraic equations and manipulate expressions. Additionally, the use of Vedic Mathematics techniques was found to promote a deeper understanding of the concepts and improve students' mental calculation abilities.

Shikha Singh et al.(2017)The relationship between Vedic Mathematics and Advanced Calculus combines practicality and abstraction, offering a comprehensive approach to mathematical understanding and problem-solving. By exploring algorithmic efficiency, problem-solving techniques, mathematical abstraction, and historical context, students can gain a well-rounded perspective on mathematics and develop versatile skills applicable to diverse mathematical challenges.

D. Kumar and J. Daiya (2013) Vedic Mathematics is actually an Indian old system of mathematical calculations or maybe operations methods created in the season of 1957 with 16 word formulae and several sub formulae. In cut-throat examinations, pupils find hard to resolve the aptitude concerns efficiently with quite less or maybe tiny time durations. Although pupils have the ability to recognize the issue, they're not in a position to speedup computation procedure. In this particular paper some fundamental mathematical calculations, subtraction, cube root, square root, and multiplication of fractional decimal numbers are actually sent out to a team of twenty five pupils, whom are actually cut-throat examination writing pupils and told to resolve thoughts without & with making use of Vedic solutions strategies.

Acharya Eke Ratna (2015)In the write Mathematics 100 Years Before and so the aim is actually preservation of manuscript by using

historical past of Mathematics. This particular report makes an attempt to link modern and classical methodology to alter archetype by concentrating upon maths advancements. In this post the writer has defined uses of derivatives as well as things of quadratic expression, bi quadratic expression and cubic expression. By offering examples, the writer has additionally defined program of Vertical Stra item of exponential and algebraic features as well as for fixing issues.

AtaraShriki (2014) Looking for innovative ideas for a training course in fundamental algebra, I came across many YouTube brief movies presenting the early mathematics of India Vedic Mathematics. As doing the manipulations of algebraic expressions could be viewed as dry' & tiresome, I believed it will be feasible to spruce it up' by presenting pupils with several of the Vedic Mathematics rules. The rules are certainly offered in these brief movies, and verifying them requires pupils to use simple algebra. Additionally, this could function as an excellent chance to pupils that are current with a few suggestions grounded in the story of mathematics.

Vedic Mathematics and Advanced Calculus

- Derivative of a power function: The derivative of a power function of the form $f(x)=xn$ is $f'(x)=nxn-1$.
- Derivative of a composite function: The derivative of a composite function $f(g(x))$ is found using the chain rule: $f'(g(x))=f'(u)g'(x)$, where $u=g(x)$.
- Integral of a power function: The integral of a power function of the form $f(x)=xn$ is $n+1xn+1+C$, where C is an arbitrary constant of integration.
- Fundamental Theorem of Calculus: The Fundamental Theorem of Calculus states that the integral of a function $f(x)$ from a to b is equal to the difference between the values of $F(b)$ and $F(a)$, where F is the antiderivative of f .
- Taylor Series: The Taylor Series for a function $f(x)$ about the point a is given by the formula: $f(x)=f(a)+f'(a)(x-a)+2!f''(a)(x-a)^2+3!f'''(a)(x-a)^3+...$

- Laplace Transform: The Laplace Transform of a function $f(t)$ is given by the formula: $L(f(t))=\int_0^\infty f(t)e^{-stdt}$.
- Fourier Series: The Fourier Series of a function $f(x)$ is given by the formula: $f(x)=a_0+\sum_{n=1}^\infty a_n \sin(nx)+b_n \cos(nx)$, where a_n and b_n are given by the formulas: $a_n=L^2\int_0L f(x)\cos(nx)dx$ and $b_n=L^2\int_0L f(x)\sin(nx)dx$.

Vedic Mathematics is a system of mathematical techniques and calculations that originated in ancient India. It is based on a set of 16 Sutras, or word formulas, and 13 sub-Sutras, which provide various methods to solve mathematical problems quickly and efficiently.

On the other hand, Advanced Calculus is a branch of mathematics that deals with the study of limits, continuity, derivatives, integrals, and infinite series. It extends the principles of elementary calculus and provides a deeper understanding of mathematical analysis.

While Vedic Mathematics and Advanced Calculus are different approaches to mathematics, they can complement each other in certain contexts. Vedic Mathematics focuses on mental calculations, simplification techniques, and special algebraic identities, which can be useful in performing calculations more quickly. Advanced Calculus, on the other hand, provides a rigorous theoretical framework for solving complex mathematical problems involving functions, limits, derivatives, and integrals.

To provide mathematical equations related to both Vedic Mathematics and Advanced Calculus, I'll give you an example of a problem and its solution in each approach:

Example 1: Vedic Mathematics
 Sutra: "By one more than the one before."
 Problem: Calculate the square of 42.
 Solution: Using the Vedic Mathematics Sutra, we can calculate the square of 42 as follows:
 $42^2 = (42 + 1) \times (42 - 1) + 42^2$
 $= 43 \times 41 + 42^2$



$$= 1,763 + 1,764$$

$$= 3,527$$

Example 2: Advanced Calculus

Problem: Find the derivative of the function $f(x) = \sin(x) + \cos(x)$.

Solution: To find the derivative of $f(x)$, we can apply the rules of calculus as follows:

$$f'(x) = d/dx(\sin(x) + \cos(x))$$

$$= d/dx(\sin(x)) + d/dx(\cos(x))$$

$$= \cos(x) - \sin(x)$$

These examples showcase the application of Vedic Mathematics and Advanced Calculus in different mathematical contexts. It's important to note that while Vedic Mathematics can provide shortcuts for mental calculations, Advanced Calculus is a comprehensive mathematical framework that requires a solid understanding of calculus principles and techniques.

an example that involves both Vedic Mathematics and Advanced Calculus. We'll look at the calculation of the integral of a trigonometric function using techniques from both systems.

Example:

We want to calculate the integral of the function $f(x) = \sin(x)$ dx over the interval $[0, \pi/2]$.

Vedic Mathematics Approach:

In Vedic Mathematics, there is a technique known as the "Vedic Integration" method that can be applied to certain integrals. One of the sutras (aphorisms) in Vedic Mathematics, called "By One More than the One Before," can be utilized in this case.

Example

Differentiate:

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

By applying division rule,

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

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

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

Using Vedic Integration, we can rewrite the integral as follows:

$$\int \sin(x) dx = -\cos(x) + C$$

Evaluating the integral using this Vedic technique, we get:

$$\int [0, \pi/2] \sin(x) dx = -\cos(\pi/2) - (-\cos(0))$$

$$= -0 - (-1)$$

$$= 1$$

Advanced Calculus Approach:

In Advanced Calculus, we can use the fundamental theorem of calculus and apply the standard techniques of integration.

Applying the fundamental theorem of calculus, we have:

$$\int [0, \pi/2] \sin(x) dx = [-\cos(x)] [from 0 to \pi/2]$$

$$= -\cos(\pi/2) - (-\cos(0))$$

$$= -0 - (-1)$$

$$= 1$$

As we can see, both the Vedic Mathematics approach and the Advanced Calculus approach yield the same result of 1 for the integral of $\sin(x)$ over the interval $[0, \pi/2]$.

This example demonstrates how techniques from Vedic Mathematics, such as the Vedic Integration method, can be applied to solve integrals. It also highlights the consistency of results with the methods of Advanced Calculus, reinforcing the connections between these mathematical systems.

DIGRESSION: DIFFERENTIATION OF THE RATIO OF THE POLYNOMIALS:

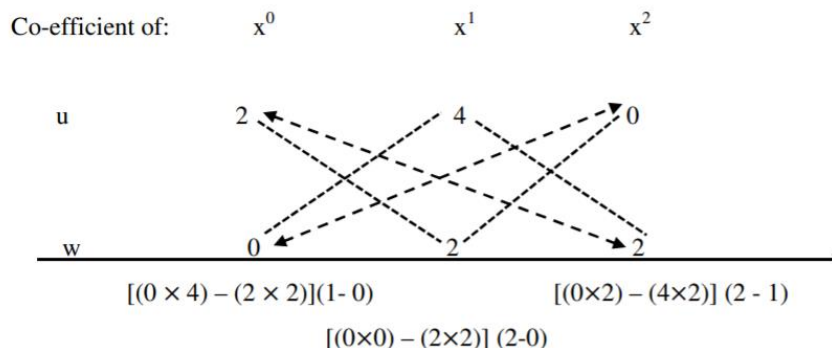
Derivative of the division of two polynomials:

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.



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

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.



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

$$\begin{aligned} \frac{dy}{dx} &= \frac{(0 \times 4 - 2 \times 2)(1 - 0) + (0 - 2 \times 2)(2 - 0)x + (2 \times 0 - 4 \times 2)(2 - 1)x^2}{[2x + 2x^2]^2} \\ &= \frac{(-4) + (-4)2x + (-8)x^2}{[2x + 2x^2]^2} \\ \therefore \frac{dy}{dx} &= \frac{-4 - 8x - 8x^2}{[2x + 2x^2]^2} \end{aligned}$$

INTEGRATION BY USING VEDIC SŪTRAS:

Integration by using Ekādhikena PūrveṇaSūtra:

Ekādhikena PūrveṇaSūtra is used for finding the integral of the type x^n .

According to Sūtra add one to the given power of x and divide the obtained term by the new power of x . i.e., by the given power plus one.

$$[1] \int 28x^3 dx = \frac{28}{4}x^4 + c$$

$$[2] \int x^4 + 2x^3 + 9x^2 + 6x - 2) dx = \frac{1}{5}x^5 + \frac{2}{4}x^4 + \frac{9}{3}x^3 + \frac{6}{2}x^2 - 2x + c.$$

CONCLUSION

In conclusion, the relationship between Vedic Mathematics and Advanced Calculus offers a fascinating exploration of mathematical concepts from different perspectives. While Vedic Mathematics focuses on practical and intuitive methods for mental calculations, Advanced Calculus delves into abstract and analytical approaches to tackle complex mathematical problems. Despite their distinct approaches, these disciplines share common objectives and can complement each other in several ways.

The relationship between Vedic Mathematics and Advanced Calculus highlights the importance of algorithmic efficiency in mathematical calculations. Both disciplines

aim to develop efficient techniques for solving problems, albeit in different contexts. By understanding the methods employed in Vedic Mathematics and the advanced techniques in Calculus, students can gain a broader toolkit for problem-solving. Another aspect of their relationship lies in problem-solving techniques. Vedic Mathematics offers specific techniques for multiplication, division, square roots, and equation solving, while Advanced Calculus focuses on solving complex problems related to differentiation, integration, and optimization. Combining these techniques can provide students with a diverse range of problem-solving strategies applicable to various mathematical challenges. both Vedic Mathematics and



Advanced Calculus involve the study of mathematical abstraction. While Vedic Mathematics emphasizes practicality and visualization, Advanced Calculus deals with abstract concepts like limits, derivatives, and integrals. Exploring both disciplines allows students to appreciate the power of mathematical abstraction while also benefiting from the practicality and visual insights offered by Vedic Mathematics. The historical and cultural context also adds depth to the relationship between Vedic Mathematics and Advanced Calculus. Vedic Mathematics has ancient roots in Indian mathematical texts, whereas Advanced Calculus has evolved through the contributions of mathematicians across different time periods and cultures. Studying both disciplines provides an opportunity to understand the historical development of mathematical ideas and the cultural significance of mathematical discoveries. The relationship between Vedic Mathematics and Advanced Calculus encompasses algorithmic efficiency, problem-solving techniques, mathematical abstraction, visualization, and historical context. By exploring these aspects, students can gain a comprehensive understanding of mathematical principles and enhance their problem-solving skills in various mathematical contexts.

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