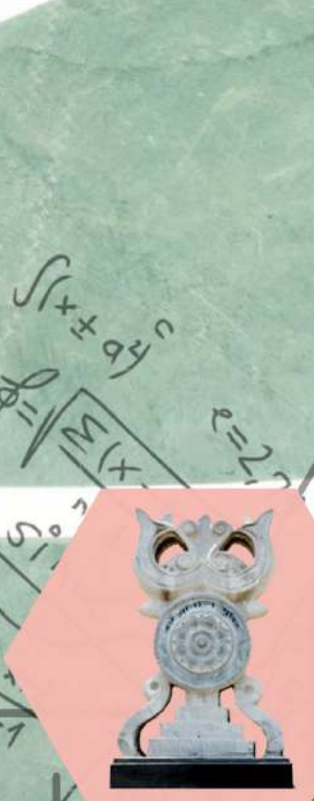
AXIOM'21

VOLUME-10

Department of Mathematics

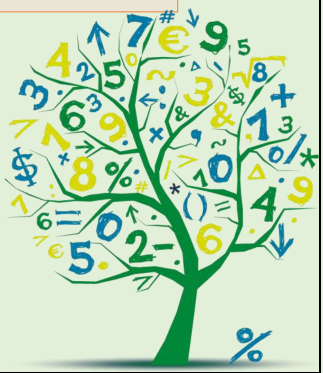
Kamla Nehru College



Editorial Board

When was ever honey made with one bee in a hive?

-Thomas Hood



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2021 NewsLetter

Teacher-In-Charge's Desk

"A teacher's purpose is not to create students in his image, but to develop students who can create their image."

Each year, the members of the editorial team work together with the students to compile the Annual Newsletter- AXIOM of the department. Though due to this time of pandemic everyone missed that bonding, physical discussions and one-to-one interaction. In spite of all this, the team compiled the AXIOM via virtual mode. This newsletter promotes the students writing skills as well as encourages them to think about the other aspects of the subject. It motivates the students to do some literature surveys on different inter-disciplinary areas and develop their research skills.

I appreciate the steady monitoring and guidance of Dr. M. M. Hasnain who mentored the students for the compilation of this newsletter. I also admire the student team who has worked hard for the same. AXIOM '21 will highlight the different approaches, ideas and curiosity of the students.

"Once we accept our limits, we go beyond them." ***— Albert Einstein***

Dr. Pooja
Teacher-in-charge

Editor's Desk

"In the end, what makes a book valuable is not the paper it's printed on, but the thousands of hours of work by dozens of people who are dedicated to creating the best possible reading experience for you." ***— John Green***

It has been a great honor and pleasure for me to be involved as an Editor of Axiom'21 – Annual Newsletter of the Department of Mathematics.

Let's get on the expedition to explore the mysterious world of Mathematics and unveil it's applications in real-life which is not solely 'formulas' with this edition of the newsletter. Flip through the pages and you will not only glance at the finest articles by our brilliant students but also the activities that are organized by the department. This newsletter is an upshot of the continued efforts made by the team. Like every other year, we wanted to issue this brainchild of the department. It has come up only because everyone amalgamated so well from their places. So, I acknowledge each and every effort made by the department.

I would like to acknowledge the endeavours made by all the team members - ***Amrita Mishra, Prachi Marwaha, Sejal Sundriyal, Trisha Roy*** and ***Unnati Pandey*.** Thank you, ***Oshika Singh*** for adding value to the newsletter by designing the artistic cover page.

Not only the students but also our mentors who guide us through the journey deserve gratefulness. I am much obliged to ***Dr. Mohammad Mueenul Hasnain*** for being a great support throughout.

I would also like to extend my sincere gratitude to our Principal, ***Dr. Kalpana Bhakuni*** and Teacher-In-Charge, ***Dr. Pooja*** for giving us this platform to bring out Axiom'21. We hope everyone enjoys reading this newsletter and that it will offer you deep insight.

Ishika Arora
Editor
Axiom'21

APPROACH FROM REAL LIFE TO MATHEMATICS: DERIVATIVE

Greetings everyone/Mathematicians, now all of you must wonder as to why I greet you all with the title Mathematicians as a large number of readers may not be from the field of mathematics or don't even like this subject. Well, I feel glad if you think so because I want all of you to treasure hunt the mathematician inside you through this topic named as Derivative. Let us begin with some real-life examples to generalize this concept;

1. How do we get to know the recovery rate of certain diseases spread by virus or bacteria(a well-known example is Covid Pandemic)?
2. How do we get to know if the budget is going to help us or not? or what kind of implications or changes will it have on the economy?
3. How do we get to know the rate of our improvement in studies, job sector, or in any other field?
4. How do we get to know the minimum velocity required to project satellites in space?
5. How do we maximize profits in business? How do we get to know rapid changes taking place in climate?
6. Even in the Biology rate of muscle contraction, dissolution of drugs into the bloodstream is monitored through devices which depict graphs.

Well, most of you answer this question in a simple manner that by evaluating the rate of change w. r. t to certain parameter like time, distance etc. during small intervals (setting short term goals leads to the achievement of bigger goals), by analysing the graphs during that intervals. It is right indeed and this is the point where we can start with concept to elucidate it.

Mathematical notion of Derivative

Derivative is studied under the section of Differential Calculus which is one of the most significant and fundamental branches in Mathematics.

The derivative of a function of a real variable measures the sensitivity to change the functional value (Output value) with respect to change its argument(Input value) or we can say instantaneous rate of change. Differentiation is a process through which we find derivatives.Analysing graphs - intervals of increase, decrease[First derivative test] and check concavity [bending of curve through Second Derivative test], either the graph risesand fall or shows some stability over a period of time.We find derivatives of a continuous function for which we have to check the continuity of a function that is differentiability implies continuity of a function.

To check the continuity of a function we often use the notion of limits and we can say if both sides limit exist and are equal to the value of the function at that point, the function is said to be continuous. Limits also find application in calculation of a derivative, tangent line(vertical tangents as well) and asymptotes which help us to find the nature of a graph at a point as well as to predict its nature in long run[tending from (-) infinity to (+) infinity].Mathematically it is described as:

$$\lim_{x \to 0} \frac{f(x+h) - f(x)}{h}$$

This basic idea not only help us to calculate the slope of tangent to straight lines and known curve but also help us to visualise the real examples curve better and also lead to better prediction of the behaviour of the original system under diverse conditions. Derivative proves to be useful in various other concepts like Integration (solving daily life problems of calculating areas of unknown shapes), Differential Equations (explaining the exponential growth and decay or the change in investment return over time) etc. Now I would like the summarize the whole matter in few words that in this era where we want to see a number of changes, the basic idea behind the calculation of the rate of change may not surprise you but you would be interested in finding out whether you are getting the expected change or trend goes in vain and you can do this with the help of Mathematics (a subject with full of ideas, methodologies and experiments in it).

-Pratishtha Paliwal
1st Year

ARCHIMEDES AND THE DOOR TO SCIENCE

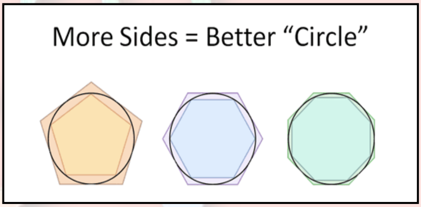
Archimedes (approximately 285-212 BC) of Syracuse was the most famous ancient Greek mathematician, physicist, engineer, inventor, and astronomer. Considered to be the greatest mathematician of ancient history, and one of the greatest of all time, Archimedes anticipated modern calculus and analysis by applying concepts of infinitesimals and the method of exhaustion to derive and rigorously prove a range of geometrical theorems, including: the area of a circle; the surface area and volume of a sphere; area of an ellipse; the area under a parabola; the volume of a segment of a paraboloid of revolution; the volume of a segment of a hyperboloid of revolution; and the area of a spiral. Archimedes' mathematical work exhibits great boldness and originality in thought, as well as extreme rigor. Archimedes was the first mathematician to calculate the value of pi and it is widely believed that the great Swiss-born mathematician Leonhard Euler (1707-83) introduced the symbol pi into common use.

Invention of pi

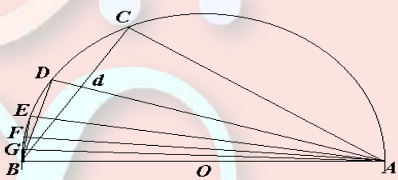
Among Archimedes' mathematical accomplishments is the computation of pi, which is the ratio of the circumference of a circle to its diameter.

$$Perimeter = \frac{Circumference}{Diameter}$$

His approach consisted of inscribing and circumscribing regular polygons with many sides in and around the circle, and computing the perimeter of these polygons. This provided him with an upper and a lower bound for pi. It had long been recognised that the ratio of the circumference of a circle to its diameter was constant, and several approximations had been given up to that point in time by the Babylonians, Egyptians, and even the Chinese.



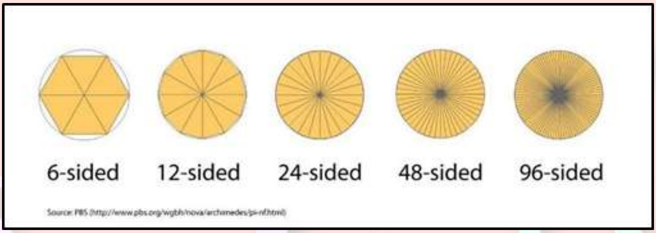
Earlier schemes for approximating pi simply gave an approximate value, usually based on comparing the area or perimeter of a certain polygon with that of a circle. Archimedes' method is new in that it is an iterative process, whereby one can get as accurate an approximation as desired by repeating the process, using the previous estimate of pi to obtain a new one.



Approximation of pi

The method of Archimedes involves approximating pi by the perimeters of polygons inscribed and circumscribed about a given circle. Rather than trying to measure the polygons one at a time, Archimedes uses a theorem of Euclid to develop a numerical procedure for calculating the perimeter of a circumscribing polygon of 2n sides once the perimeter of the polygon of n sides is known.

The ratio of the circumference of any circle to its diameter is less than $3^{1/7}$ *but greater than* $3^{10/71}$.



Then, beginning with a circu- mscribing hexagon, he uses his formula to calculate the perimeters of circumscribing polygons of 12, 24, 48, and finally 96 sides.

$$Perimeter = 2nrtan(\pi/n),$$

where n is the number of sides of a polygon.

Archimedes' Principle

Archimedes' principle, physical law of buoyancy, discovered by the ancient Greek mathematician and inventor Archimedes, stating that anybody completely or partially submerged in a fluid (gas or liquid) at rest is acted upon by an upward, or buoyant, force, the magnitude of which is equal to the weight of the fluid displaced by the body. The volume of displaced fluid is equivalent to the volume of an object fully immersed in a fluid or to that fraction of the volume below the surface for an object partially submerged in a liquid. The weight of the displaced portion of the fluid is equivalent to the magnitude of the buoyant force. It is formulated as

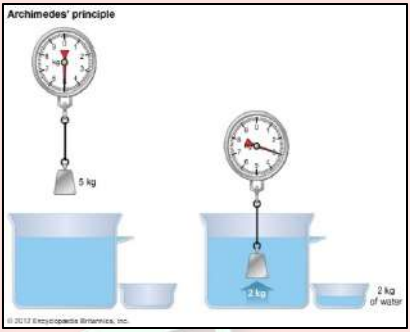
$$Fb = -\rho gV$$

Fb= buoyant force

P= fluid density

g = acceleration due to gravity

V = fluid volume.



-Anvita Agarwal
1st Year

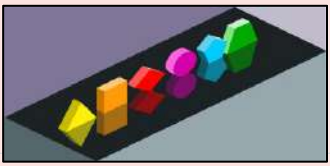
GEOMETRY

If you like playing with objects, or like drawing, then geometry is for you!

Geometry is that branch of mathematics which studies the properties of space that are related with distance, shape, size, and relative position of figures. Geometry is all about shapes and their properties.

Why do we need Geometry?

To discover patterns, find areas, volumes, lengths and angles, and better understand the world around us.

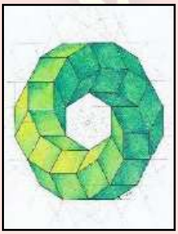


Interesting facts about GEOMETRY

- Geometry with arithmetic, is one of the oldest branches of mathematics.
- Greek Mathematician, Euclid is known as "Father of Geometry".
- A mathematician who works in the field of geometry is called a geometer.
- Pythagoras theorem is an old theorem which was prepared in around 500 BC.
- Compass was the most powerful and an ancient tool of geometry which helped in the construction of angles, measuring the lengths, and other geometric shapes.

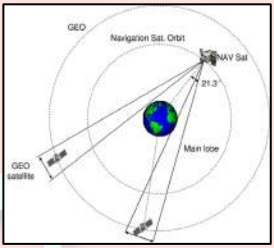
Applications of Geometry

- Mathematics and art are related in a variety of ways. For instance, the theory of perspective (a graphical representation on a flat surface of an image as seen by eyes) showed that there is more to geometry than just the metric properties of figures: and this perspective is the basis of the origin of projective geometry.



- The concept of geometry is also applied in the fields of robotics, computer, and video games. Geometry provides handy concepts both for computer and video game programmers. The way & the design of the characters that move through their virtual worlds requires geometric computations to create paths around the obstacles concentrating around the virtual world.

- Geometrical concepts are used in satellites in GPS systems; it calculates the position of the satellite and location of GPS gauged by the latitudes and longitudes.



- Geometry is used in the field of astronomy, helping to map the positions of stars and planets on the celestial sphere and describing the relationship between movements of celestial bodies.

"There is "Geometry" in the humming of the strings; there is "Music" in the spacing of spheres."

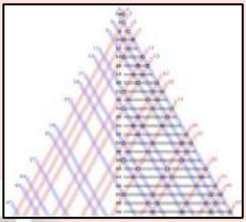
~Pythagoras

- Lavanya Tripathi
1st Year

HARDEST MATH PROBLEMS REMAINS UNSOLVED

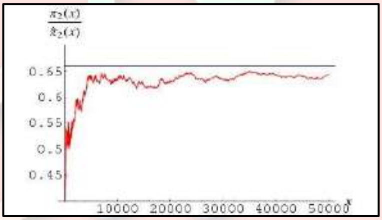
Some math problems have been challenging us for centuries; someone is bound to solve them eventually. Maybe, for now, take a crack at toughest math problems known to man, woman and machine.

Gold Bach's Conjecture



Goldbach's Conjecture states, "Every even number (greater than two) is the sum of two primes". You check this in your head for small numbers: 18 is 13+5, likewise. Computers have checked the Conjecture for numbers up to some magnitude. But we need proof for all natural numbers.

The Twin Prime Conjecture



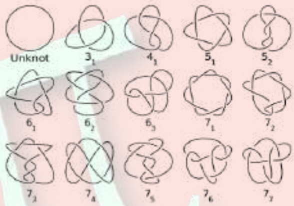
The Twin Prime Conjecture is the most famous in the subject of math called Number Theory, frequently involving prime numbers. When two primes have a difference of 2, they're called twin primes. So 11 and 13 are twin primes. Now, it's a Day 1 Number Theory fact that there are infinitely many prime numbers. So, are there infinitely many twin primes? The Twin Prime Conjecture says yes.

The Riemann Hypothesis

There is a function, called the Riemann zeta function, written in the image. For each s, this function gives an infinite sum, which takes some basic calculus to approach for even the simplest values of s. Example, if $s = 2$, then $\zeta(s)$ is the well-known series $1 + 1/4 + 1/9 + 1/16 + \ldots$, which strangely adds up to exactly $\pi^2/6$. When s is a complex number one that looks like $a + bi$, using the imaginary number i— finding $\zeta(s)$ gets tricky.

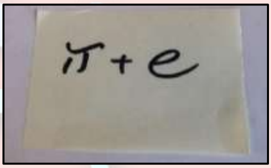
$$\zeta(s) = \sum_{n=1}^{\infty} \frac{1}{1^s} + \frac{1}{2^s} + \frac{1}{3^s} + \cdots$$

The Unknotting Problem



Knot theorists' Holy Grail problem was an algorithm to identify if some tangled mess is truly knotted, or if it can be disentangled to nothing. Several computer algorithms for this have been written in the last 20 years, and some of them even animate the process. The Unknotting Problem's computational intensity is unavoidably profound. Eventually, we'll find out.

What's the Deal with π + e?



The real number π goes back to ancient math, while the number e has been around since the 17th century. You've probably heard of both, and you'd think we know the answer to every basic question to be asked about them, right? Well, we do know that both π and e are transcendental. But somehow it's unknown whether π+e is algebraic or transcendental. Similarly, we don't know about πe, π/e, and other simple combinations of them. So, it still remains mysterious.

-Pranjul Gupta
2nd year

I AM NOT GOOD AT MATH

Every time we talk about mathematics, not only students but even adults say "I'm just no good at math”. Is it true? Is there any rationale behind this notion that some people just can't learn mathematics?

While it is true that some people are better at math than others, it is also true that a vast majority of people are fully capable of learning math. Learning math does not come as naturally as learning to speak, but our brains do have the necessary equipment. So, learning math is somewhat like learning to read, we can do it but it takes time. Virtually everyone is fully capable of understanding arithmetic procedures, algebra, geometry and probability thoroughly, to allow application to real life problems. So, automatic retrieval of such basic math facts, which we use daily, is critical to solving complex problems which have simpler problems embedded in them.

How to get good at Math?

Learning Mathematics requires three types of knowledge, factual, procedural and conceptual.

Factual knowledge refers to already knowing answers to a relatively small set of problems of addition, subtraction, multiplication and division. The answers must be memorized so that when a simple arithmetic problem is encountered the answer is not calculated but is simply retrieved from the memory. What about procedural and conceptual knowledge? A procedure is a sequence of steps by which a frequently encountered problem may be solved. Conceptual knowledge refers to an understanding of principles; knowing that multiplying two negative numbers yields a positive number is not the same thing as understanding why it is true.

For most topics, it does not make sense to teach the concepts first or to teach the procedures first, both should be taught in concert. Gaining knowledge and understanding of one supports comprehension of the other.

What to take away from this?

- Think carefully about how to cultivate conceptual knowledge, and find an analogy that can be used across all topics. Of the three types of knowledge aforementioned, conceptual knowledge is the most difficult for students to learn.

- In cultivating greater conceptual knowledge, don't sacrifice procedural or factual knowledge. Procedural or factual knowledge without conceptual knowledge is shallow, and is unlikely to transfer to new contexts, but conceptual knowledge without procedural or factual knowledge is ineffectual.

- Increased conceptual knowledge may help students move bare from competence with facts and procedures to automaticity and become good problem solvers.

- Choose a curriculum that supports conceptual knowledge. If it is indeed so difficult to learn, it would make sense to study just a few concepts from time to time and understand concepts thoroughly to expand your knowledge and avoid rote learning.

-Gauri Gupta
2nd year

INVENTION OF ZERO

The ancient Babylonians were known to have used what is often called "place holders" to differentiate between numbers like 508 and 58, there were nothing more than blank spaces or at times “two wedge shapes alike”. Around that time the Greeks did not adopt what is called a positional number system. This is because the Greeks’ achievements were based on geometry. They related numbers with lengths of line segments. Therefore, zero was not thought as a number by Babylonians neither by Greeks.

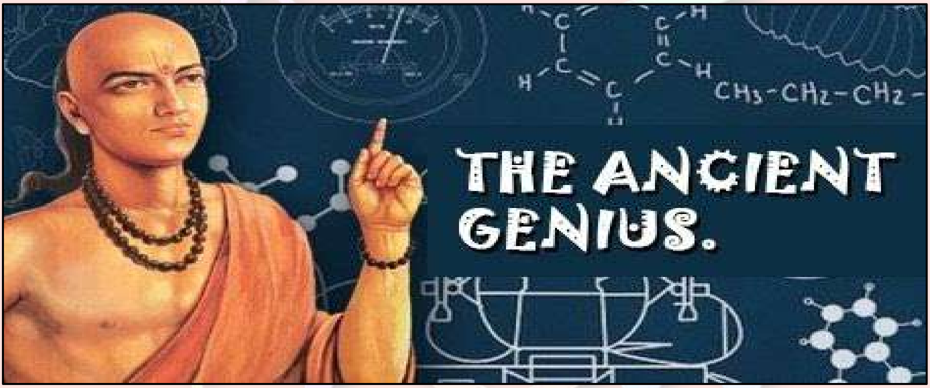
The first notions of zero as a number and its uses have been found in ancient Mathematical treatise from India and thus India is correctly related to the immensely important Mathematical discovery of the number zero. Indians began using zero both as a number in the place-value system of numerals as well as to denote an empty place. Aryabhata devised a number system which has no zero yet a positional number system. There is however, evidence that z dot has been used in earlier Indian manuscripts to denote an empty position. Later Indian mathematicians had names for zero, but no symbol for it. Aryabhata used the word "kha" for position and it was also used later as the name for zero.

The oldest known text to use zero is an Indian text entitled the Lokavibhaaga ("The Parts of the Universe"), which has been definitely dated to 25 August 458 BC. An inscription, created in 876AD, found in Gwalior, acts as the first use of zero as a number. With zero also comes the notion of negative numbers and along with all these comes a series of related questions about arithmetic operations on natural numbers, both positive and negative and zero. It is used as an additive identity of the integers, real numbers. In the 7th century Brahmagupta attempted to provide rules for addition and subtraction involving zero.

“The sum of zero and a negative number is negative, the sum of a positive number and zero is positive; the sum of zero and zero is zero. A negative number subtracted from zero is positive, a positive number subtracted from zero is negative, zero subtracted from a negative number is negative, zero subtracted from a positive number is positive,

zero subtracted from zero is zero."

Zero also reached eastwards from India to China, where Chinese scholars Chin Chiu-Shao and Chu Shih-Chieh made use of the same symbol O for a places-based system in the 12th and 13th centuries respectively. Indian scholars were influenced by Chinese Mathematicians to create their own number system.



Zero reached Europe in the twelfth century when Adelard of Bath translated Al-Khowarizmi's works into Latin. Fibonacci was one of the main mathematicians who accepted the concepts of zero in Europe. He was an important link between the Hindu-Arabic number system. The Europeans were at first resistant to this system, being attached to the far less logical Roman numeral system (notably the Romans never propounded the idea of zero), but their eventual adoption of this system arguably led to the scientific revolution that began to sweep Europe, beginning by the middle of the second millennium. However, it was not until the 17th century that zero found widespread acceptance through a lot of resistance.

-Prachi Marwaha
2nd year

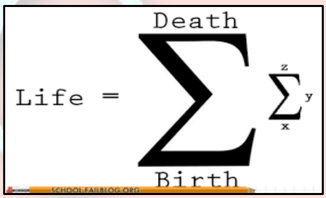
LIFE THROUGH THE EYES OF A MATHEMATICS STUDENT

"Every mathematical number or symbol has a corresponding word or phrase. Mathematics has a language of its own"

~Roopa Banerjee

Mathematics is in every facet of our lives. From birth till death, from a child-parent relationship to the challenges of life. We can communicate via dance, words, songs, signs, numbers, sound and what not. In similar terms, Mathematics is a language of signs, symbols and expressions.

The emotional distance between a parent and a child always tends to 0 as the physical distance tends to miles and miles away i.e., $F(x) = 0$ *as* $x \to \infty$. Siblings are like an *integral domain* because of the absence of zero divisors which implies they are (You x Your Sibling) $= 0$ as their love for each other makes them an identity together. True friends and love are 'Constant' functions that do not change in any case.



We integrate small moments during the course of life which become beautiful memories for life. Every person yearns for things in life though ∞ is not real. The human emotions behave like *'Sine'* function that oscillates from saddest to the happiest back and forth in seconds. Mankind generally behaves like a *'Modulus'* function as they react positively or negatively according to the circumstances or people around them. The *Derivative* of a function of a human behaviour and habits measures the sensitivity to change of the function value with respect to a change in their circumstances and surroundings.

The responsibilities on our shoulders are an increasing function like x^2 in our life where $x =$ our days of existence in the world. The Limit of life as age approaches to 'a' is Success if for every Effort > 0there exists a Result > 0.

Life is a Complex number with harsh Realities as well as beautiful Imaginary Components. The most important lesson Mathematics teaches us is the will to never give up on this precious life as every problem has a solution though it takes a lot of patience and composure.

-Ishika Arora
2nd year

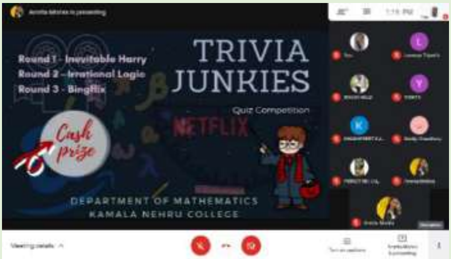
A Glimpse of 2020-21

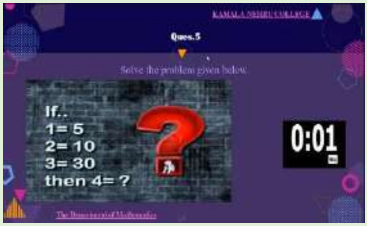
Omicron'21

The Annual Mathematics Fest - *Omicron'21* was organized by the adept students of Mathematics Department on 4th March,2021. Keeping in mind the Covid-19 situation, it was held purely online instead of sitting hands down.

The event commenced with the Inaugural Guest Lecture by ***Prof. Pravin Sinclair***, Mathematician and Educationist who is currently working as a Professor of Mathematics at Indira Gandhi National Open University and also serves as the trustee of Aruna Sinclair Foundation. It was followed by another Guest Lecture by ***Dr. Rita Malhotra***, the former Principal of Kamala Nehru College, on the very intriguing topic- "*The Fascinating World of Infinities and their Reciprocals*".

The fest then proceeded with the informal events, the first being Paper Presentation on the enticing topic - *'Mathematics and Pandemic'*. Other events included *Trivia Junkies* - The Quiz Competition, *Eureka* - The Treasure Hunt, *Brainzy*, *Kala-E-Maths*- the Rangoli Competition that showed the colours of mathematics in real world. All the events were held online with ample of registrations.





The fruit of students' long haul and mentors' support was the palmy event.

Webinar – "Unfastening the social knots against Mathematics"

The Mathematics Department, Kamala Nehru College, organized a webinar on 11th June, 2020 through the Zoom platform. The topic was very engaging – *"Unfastening the social knots against Mathematics*." The speaker of the event was *Dr. Rita Malhotra*, a mathematician, poet, essayist and former principal, Kamala Nehru College. She has also received the honor of the World Congress of Poets 2019.

The webinar was in the form of an open lecture where Dr. Rita talked about how students have a fear to study Mathematics and how teachers can play a great role in eliminating those fears. She took up the

stereotypes attached to Mathematics and how we can overcome them. She discussed how professors can galvanize the students and make Mathematics a subject more approachable and interesting.

Over 150 students and teachers from various colleges of Delhi University participated in the webinar. Registrations were done beforehand. The webinar concluded with a Question-Answer round where students brought up their doubts. E-certificates were provided to the participants. The webinar was informative and winning.

Webinar – "Introduction to Wolfram Mathematica"

The Mathematics Department, Kamala Nehru College, organized a webinar workshop on 31st August, 2020. The topic was *"Introduction to Wolfram Mathematica"* and it was held through Microsoft Teams. The speaker of the workshop was *Mr. Mahendra Singh Bisht*, System Engineer SCUBE Scientific Software Solution Pvt. Ltd., New Delhi.

The webinar aimed to explore the technologies on the Wolfram Platform, how to use the various features of Mathematica for the practical application. Wolfram Mathematica is a software system used in many technical, scientific, engineering, mathematical and computing fields. The webinar was very explanatory and useful.

INTERESTING FACTS ABOUT MATHEMATICS

1. From 0 to 1000, the only number that has the letter "a" in it is "One Thousand".

2. Teenagers texting in Thailand will send the digits 555 to indicate that something is funny. In the Thai language, 5 is pronounced as ha which when translated becomes hahaha!

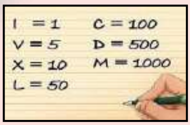
3. In a room of 23 people there are 50% chances that two of them will share the same birthday this is known as the birthday problem.

P.S- In our class there are 45 students in which Yogita Garg and Khushi are sharing the same birthday.

4. "Four" is the only number in the English language that is spelt with the same number of letters as the number itself and also "Forty" is the only number that is spelt with the letters arranged in alphabetical order.

5. Multiplying ones always gives you Palindromic numbers. If you multiply $111111111 \times 111111111$ you get 12345678987654321 a palindrome number that reads the same forwards or backwards.

6. Roman numerals only have seven different letters which form the entire number system: I, V, X, L, C, D and M.



7. The numeral 4 is associated in Japanese and Chinese cultures with "death" (Many Chinese hospitals do not have a $4th$ floor).

8. 9 is known as the magic number. This is because if you multiply a number by 9 and add all the digits of the new number together, the sum will always add up to9. For example:

$$8 \times 9 = 72 \text{ or } 7 + 2 = 9.$$

9. The reason Americans call mathematics "math" is because they argue that "mathematics" functions as a singular noun so "math" should be singular too.

10. Number four is viewed with superstition and distrust and much of East Asia. This is known as tetra phobia. This is because the word four sounds similar to that in a number of Asian languages.

11. Zero is not represented in roman numerals.

12. If you walk upon a street and ask someone about their favourite number there is almost a 10% chance that they will say number7.

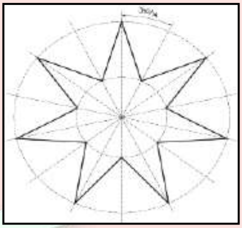
-Yogita Garg
1st Year

MATHEMATICAL APPROACH FOR GRAPHIC DESIGNS

Mathematics is the most beautiful thing in our daily life but when it comes to equations and formulae people seem to be unpleased. It can be hard like calculus or may be basic intermediate algebra but the graphic designers have to go through it. Golden ratio, Fibonacci number, number theory, geometry etc. are the common mathematical techniques that are used to design web pages, computer graphics etc.

Geometry

So, there is a fun subset of math that's devoted to geometry. It really helps you in things like drawing and perhaps composition. Let's take an example: A client asks you to draw a 7 sided star. Okay, so you know that the angle between the points is $\frac{360}{7}$ and each high and low is $\frac{360}{(2\times7)}$. So, you get the figure as drawn.



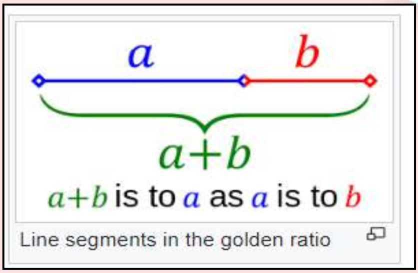
Golden ratio

Two quantities are in the golden ratio if their ratio is the same as the ratio of their sum to the larger of the two quantities.

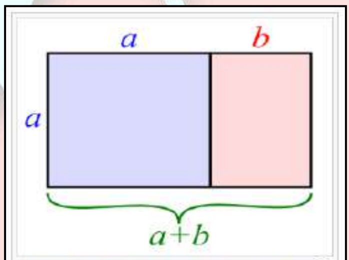
$$\frac{a+b}{a}=\frac{a}{b}=\varphi\ (def),$$

Expressed algebraically, for quantities a and b with $a > b > 0$, where the Greek letter φ is representing the golden ratio. It is an irrational number that is a solution to the quadratic equation $x^2 - x - 1 = 0$, with a value of

$\varphi = \frac{1+\sqrt{5}}{2} = 1.6180339887$



Line segments in the golden ratio



A golden rectangle with long side **a** and short side **b** adjacent to a square with sides of length **a** produces a similar golden rectangle with long side **a + b** and short side **a**. This illustrates the relationship $\frac{a+b}{a}=\frac{a}{b}\equiv\varphi$.

Fibonacci numbers

In mathematics, the Fibonacci numbers, commonly denoted Fn, form a sequence, called the Fibonacci sequence, such that each number is the sum of the two preceding ones, starting from 0 and 1. That is,

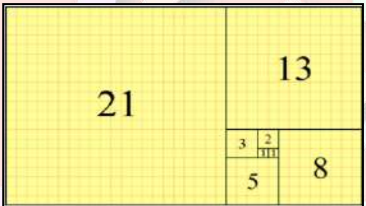
$$F_0 = 0, F_1 = 1$$

and

$$F_n = F_{n-1} + F_{n-2}$$

for $n > 1$, the beginning of the sequence is thus:

$$0, 1, 1, 1, 3, 5, 8, 13, 21, 34, 55, 89, 144, \dots \dots$$



A tiling with squares whose side lengths are successive Fibonacci numbers: 1, 1, 2, 3, 5, 8, 13 and 21

In some older books, the value is $F_0=0$ is omitted, so that the sequence starts with $F_1 = F_2 = 1$ and the recurrence $F_n = F_{n-1} + F_{n-2}$ is valid for $n > 2$.

Fibonacci numbers are strongly related to the golden ratio: Binet's formula expresses the nth Fibonacci number in terms of n and the golden ratio, and implies that the ratio of two consecutive Fibonacci numbers tends to the golden ratio as n increases.

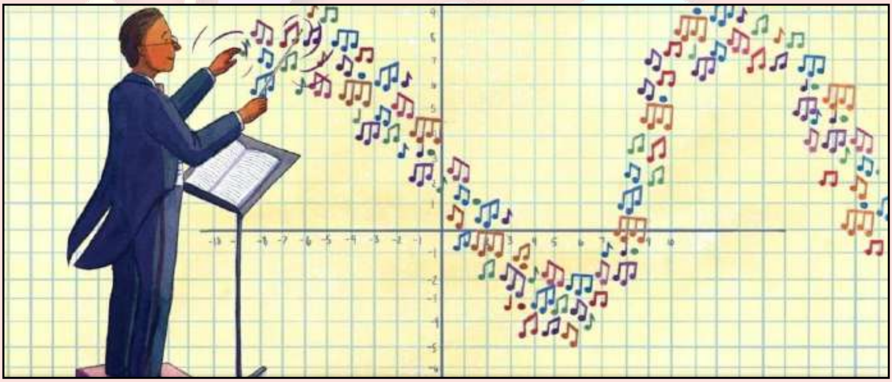
-Mansi Gupta
1st Year

MUSICAL MATHEMATICS

Mathematics is a subject that is some or the other way involved in every field of study that is known to mankind. Have you ever thought about *mathematics in music*? Well, you ought to believe that any possible situation that has any relationship whatsoever to space, time or thought does involve mathematics in it and similar is in case of music.

Greek philosopher Pythagoras was among the first historical figures to emphasize the relation between music and mathematics. He elucidated how mathematical ratios help to define every system of intonation throughout history. In other words, we tune our modern day instruments using the mathematics that Pythagoras introduced 2500 years ago.

Isn’t it fascinating that the chords we use can be built using fractions? This theory revolves all around ratios. All else being equal, if you pluck two strings on a stringed instrument, any difference in the sound they produce is all because of the difference in the length of strings.



Longer strings vibrate more slowly producing deeper sounds, while shorter will vibrate more quickly, producing higher sounds. So when a pair of notes sounds pleasing, what it actually means is that the strings producing the notes have lengths that are in pleasing ratios.

Well, have you heard about the “Golden Ratio”? It has turned out that the golden ratio is shown up in many designs that captivate and delight us. It is basically the irrational number Phi that is generally equal to 1.618. It would take some time to understand what exactly happens with the golden ratio but you need not really have to understand the numbers to start observing this ratio in the musical world.

Phi moment experiment

Take your favourite song and find out how many seconds it has. Then, multiply that by0.618. Now, head to that point in the song and see what you find. I gave it a try with few of my favourites and the majority were either at a high point in a song or just reaching it.

Research has even shown how certain pieces of music end up being more popular because of their mathematical structure. The best part about this is how knowing about ratios and patterns like this can leave us walking through the world of musical mathematics in awe.

-Sejal Sundriyal
2nd Year

ROLE OF PI IN OUR LIFE

Pi is one of the simplest words, having a complex nature and vast use. We usually say it is the ratio of the circumference to the diameter of a circle or 22/7 or3.14. Moreover, it is an irrational number and is infinite. But to our wonder it is not only used in mathematics but in different fields as well as in our daily life. No doubt we live in a diverse and complex environment and all biotic-abiotic components comprise Pi in it thus making this topic more crucial and interesting.

Applications of Pi:

Just as Pi is infinite it helps in studying the infinite starts in the universe. The ultimate sun, moon, our planet earth and its rotation as well as the orbit all have the use of Pi. Yes, there is Pi in the sky too, all the layers of atmosphere and its density are studied with the help of Pi. Coming down to earth and its environment we cannot deny the fact that Pi is used everywhere and in our everyday life like the fan above us, clock, round and cheesy pizzas, bangles, the tyers that take us miles away, motors, football, arches, bridges, churches and buildings etc. Pi does have infinite uses and as a result we celebrate World Pi Day on 14 March.

Surprisingly, Pi can also be found within our body. Pi is found in the pupil of the eye and in the most basic structure of the human body – the DNA. Pi is found in sine waves that is used for signal processing in sound and light waves. Pi can be helpful in studying the behavior of ocean waves – their frequency, wavelength and amplitude. Pi comes into play even when we are talking over phone, watching television or listening to the radio. Even if we don't think about it but it is there and is used all the time, indeed it is strange and amazing yet we are not done here following are some examples of uses of Pi in different professions:

1. Electrical engineers use pi to solve problems for electrical applications
2. Statisticians use pi to track population dynamics
3. Biochemists see pi when trying to understand the structure/function of DNA
4. Clock designers use pi when designing pendulum for clocks
5. Aircraft designers use it to calculate areas of the skin of the aircraft
6. Seismologists use pi to study the seismic waves
7. Mathematicians use pi to solve mathematical problems.

Thus, the creation pi has helped us in many ways and being a math's student, we know how important role it has in our studies. It astonishes us to know the various uses of pi in our daily life and there are many more examples which one can think about.

-Sanisha Gurung
2^{nd} Year

THE MATHEMATICAL SECRET OF COMPUTER GAMES

Most of us live under the idea that Mathematics and Computer science are two different fields which are completely unrelated to each other. All of us are fond of playing video games and creating computer graphics. While on the other hand, when it comes to Mathematics, we tend to shy away from the topic. But in reality, *Mathematics is the secret behind every video game to ever exist!* Shocking, right?

There are indeed many mathematical principles behind the creation of computer games including: geometry, vectors, transformations, matrices and physics. In this article we'll be particularly focusing on how Matrices are used to create 3D Gaming systems and graphics.

Matrix Operations used:

In the video gaming industry, matrices are major mathematical tools to construct and manipulate a realistic animation of a polygonal figure. Examples of matrix operations include ***translations, rotations, and scaling***. Other matrix transformation concepts like field of view, rendering, color transformation and projection. Understanding of matrices is a basic necessity to program 3D video games.

A. Transformation of points: In general, transformation of points can be represented by this equation:

$$Transformed\ Point\ = Transformation\ Matrix\ x\ Original\ Point$$

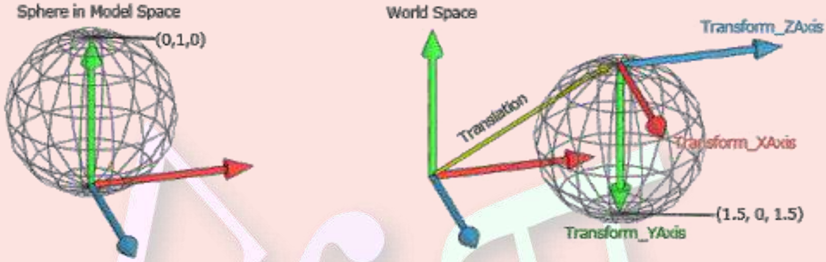


Figure : Example of transformation of an object

B. Translation: A translation basically means adding a vector to a point, making a point transform to a new point. This operation can be simplified as a translation in homogeneous coordinates (x, y, z, 1) to (x + t_x, y + t_y, z + t_z, 1). This transformation can be computed using a single matrix multiplication.

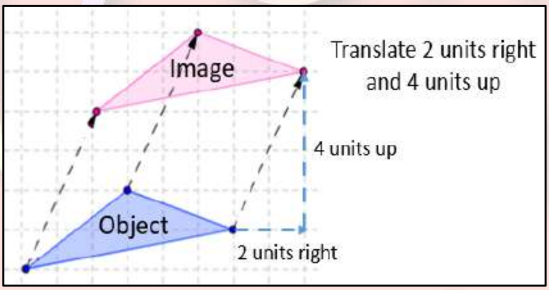


Figure: Example of translation of an object

C. Scaling: Scaling of any dimension requires one of the diagonal values of the transformation matrix to equal to a value other than one. This operation can be viewed as a scaling in homogeneous coordinate $(x, y, z, 1)$ to $(s_x\, x, s_y\, y, s_z\, z, 1)$. Values for s_x, s_y, s_z greater than one will enlarge the objects, values between zero and one will shrink the objects, and negative values will rotate the object and change the size of the objects.

$$\begin{bmatrix} sx & 0 & 0 & 0 \\ 0 & sy & 0 & 0 \\ 0 & 0 & sz & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} . \begin{bmatrix} x \\ y \\ z \\ w \end{bmatrix} = \begin{bmatrix} x.sx \\ y.sy \\ z.sz \\ w \end{bmatrix}$$

Figure : Scaling matrix

D. **Rotation:** Rotations are defined with respect to an axis. In 3 dimensions, the axis of rotation needs to be specified. Rotation about x, y and z axis are shown below:

$$R_x(\theta) = \begin{bmatrix} 1 & 0 & 0 \\ 0 & \cos\theta & -\sin\theta \\ 0 & \sin\theta & \cos\theta \end{bmatrix}$$

$$R_y(\theta) = \begin{bmatrix} \cos\theta & 0 & \sin\theta \\ 0 & 1 & 0 \\ -\sin\theta & 0 & \cos\theta \end{bmatrix}$$

$$R_z(\theta) = \begin{bmatrix} \cos\theta & -\sin\theta & 0 \\ \sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

Conclusion

There are many other such applications of matrices that are essentially used in creating computer graphics and games. Not only is there fundamental mathematics behind the creation of the games but also for playing them. For example, one of the main mathematical skills required to succeed in playing most games is problem solving. Knowing and using these principles make our work much easier and fun. And who knows, maybe exploring these facts and putting them to use might even get you over your fear of maths and numbers!

-Trisha Roy
2nd Year

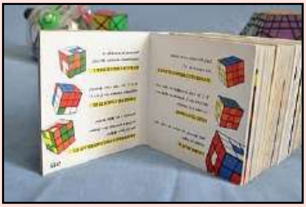
THE MATHEMATICS OF THE RUBIK'S CUBE

The Rubik's Cube is a 3-D combination puzzle invented in 1974 by Hungarian sculptor and professor of architecture Erno Rubik. Originally called the Magic Cube, the puzzle was licensed by Rubik to be sold by Ideal Toy Corp. Rubik's Cube won the 1980 German Game of the Year special award for the Best Puzzle. On the original classic Rubik's Cube, each of the six faces was covered by nine stickers, each of one of six solid colours: white, red, blue, orange, green and yellow. In models as of 1988, white is opposite yellow, blue is opposite green, and orange is opposite red, and the red, white, and blue are arranged in that order in a clockwise arrangement.

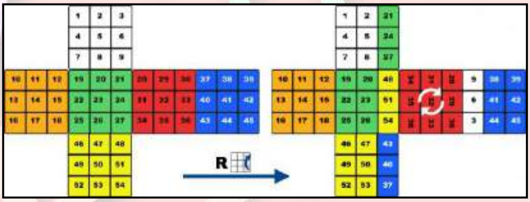
God's Number

God's Number shows the smallest number of moves needed to solve $3 \times 3 \times 3$ Rubik's Cube from any random position. Since July of 2010 we know that this number is 20, so every position can be solved in 20 moves or less, considering one move, a 90 degree or 180 degree twist of any face.

This number was calculated thanks to Google who donated 36 CPU years of idle computer time, solving every position of the Rubik's Cube in less than 21 moves. The first estimation of the God's Number was 52 in July 1981. Then this number was gradually decreasing 42 in 1990, 29 in 2000, 22 in 2008 and reaching the final number of 20.



Mathematics



The original $(3 \times 3 \times 3)$ Rubik's Cube has 8 corners and 12 edges. There are 8! (40,320) ways to arrange the corner cubes. Each corner has 3 possible orientations, although only 7 (of 8) can be oriented independently; the orientation of the 8th (final) corner depends on the preceding 7, giving 3^7 (2,187) possibilities. 11 edges can be flipped independently, with the flip of the 12th depending on the preceding ones, giving 2^{11} (2048) possibilities.

$$8! \times 3^7 \times \frac{12!}{2} \times 2^{11} = 43{,}252{,}003{,}274{,}489{,}856{,}000$$

which is approximately 43 quintillion. If one considers permutations reached through disassembly of the cube, the number becomes 12 times larger:

$$8! \times 3^8 \times 12! \times 2^{12} = 519{,}024{,}039{,}293{,}878{,}272$$

which approximately 519 quintillion possible arrangements of the pieces that make up the cube, but only 1 in 12 of these are actually solvable. This is because there is no sequence of the moves that will swap a single pair of pieces or rotate a single corner or edge cube. Thus, there are 12 possible sets of reachable configurations, sometimes called "universes" or "orbits", into which the cube can be placed by dismantling and reassembling it.

The preceding numbers assume the centre faces are in a fixed position. If one considers turning the whole cube to be a different permutation, then each of the preceding numbers should be multiplied by 24. A chosen colour can be on one of six sides, and then one of the adjacent colours can be in one of four positions; this determines the positions of all remaining colours.

-Sneha Singh
1st Year

UNFORTUNATE NUMBER 13: MYTH OR REALITY?

The number 13 has many meanings and interpretations in different religions and parts of the world. The number 13 is considered an unlucky number in some countries. Fear of the number 13 has a specifically recognized phobia, triskaidekaphobia. The superstitious sufferers of *triskaidekaphobia* try to avoid bad luck by keeping away from anything numbered or labelled thirteen, with hotels and tall buildings being conspicuous examples (thirteenth floor).

Each year the even more specific fear of Friday the 13th , results in financial losses in excess of $800 million annually. Just like walking under a ladder, crossing paths with a black cat or breaking a mirror, many people hold fast to the belief that Friday the 13th brings bad luck.

But what's so unlucky about the number 13, and how did this numerical superstition get started?

According to biblical tradition, 13 guests attended the Last Supper, including Jesus and his 12 apostles. The next day, of course, was Good Friday, the day of Jesus' crucifixion.

Just as Jesus was crucified on a Friday; Friday was also said to be the day Eve gave Adam the fateful apple from the Tree of Knowledge, as well as

the day Cain killed his brother, Abel; Apollo 13 which was launched on 11th April underwent explosion on 13th April. The number 13 is occasionally thought of as unlucky in other countries too, although this is imported from Western culture.

Does number 13 really deserve such loathing?

Every month of Hindu calendar, the 13th day is an auspicious day for Hindus. The 13th day in the calendar is called Trayodashi and is dedicated to Lord Shiva. Maha Shivaratri, the biggest festival dedicated to Lord Shiva, is celebrated on the 13th night in the month of Magh; Our auspicious festival Lohri is celebrated On 13th January; every year as well as Baisakhi is celebrated on 13th of April ;there are 13 Buddhas in the Shingon sect of Buddhism; The US flag has 13 strips, that represent the union of 13colonies to fight British rule, later these 13 colonies became the first thirteen states of the United States Of America; in Greek mythology ,Zeus is the thirteen and most powerful god. Age 13 signifies maturity in Judaism and also the Thai new year is celebrated on April 13.

The fear about number 13 is the 20th century creation and we are able to find quite many exceptions for this phenomenon to show that this is a myth and a baseless superstition created by us.

-Ruchita Sareen
2nd Year

WOMEN IN MATHEMATICS

"For most of history, anonymous was a woman"

As barbarous as this sentence might sound, it is, in fact, the truth.Humans are considered to be the superior species because of our ability to question everything and find the solutions but because of gender discrimination women weren't able to go any further than questioning the way of things.

As kids we were told stories about Newton, Einstein, Stephen Hawking etc and were told to look up to them, be as inquisitive as them. But rarely ever were we told stories about a woman scientist. Now that things have changed and women are no longer looked at as the weaker sex by a large section of the society, being a 21st century women studying mathematics at a women's college, we ought to know about these three women who made their contributions towards the initial discoveries in the field of science and mathematics.

Hypatia (born c. 350–370; died 415 AD) –

Was a philosopher, astronomer and a mathematician. She is known to be the first female mathematician whose life is well recorded. Though it is said that she merely wrote commentaries on Diophantus' *Arithmetica*and Apollonius of Perga's work on conic sections and wrote school editions of such works but a high degree of mathematical accomplishment would have been needed to comment on such topics and thus most scholars today recognize that Hypatia must have been among the leading mathematicians of her day.

Émilie du Châtelet (born 17 Dec. 1706 –10 Sept. 1749)–

Was a French natural philosopher and a mathematician. One of her most important contributions to science was her elucidation of the concepts of energy and energy conservation. She conducted experiments and thus suggested that energy is proportional to mv2, not mv, as Newton had suggested. She participated in famous debates, concerning the best way to measure the force of a body and the best means of thinking about conservation principles. She also translated the famous *Principia* by Newton during the last few months before she died.

Marie-Sophie Germain (born 1 April 1776 – 27 June 1831) –

Was a French mathematician, physicist and a philosopher. She was one of the pioneers of *elasticity* theory and was the first woman to win the

grand prize from Paris Academy of Sciences for her essay on the subject. She also contributed significantly in the field of number theory by providing the proof for a part of *Fermat's Last Theorem.*

These women and many others had a fascination towards science from a very young age. They went against their family wishes and social prejudices of the time and make contributions to the field of science and mathematics relentlessly until they got recognized and appreciated. They paved the way for the women of our generation, and so, we should deem it our responsibility to carry forward their legacy, start where they left off and try to become good role models for the coming generations.

-Unnati Pande
2nd Year

MATHEMATICS: HYPE?

Mathematics is not a hype,
Who said it's not our type?
We play with numbers like our doll,
Dolls or numbers, it's our call.
Calling us weak, makes you stud,
Mathematical equations, it's in our blood.
Pilot, astronaut, teacher or housewife,
Mathematics is always a part of our life.
Addition was same as bringing smiles,
Subtraction was always sacrificing at times.
We learnt division when took your grieves,
And multiplication comes when a life we release.

Whether it’s home or dealing the boss,
We very well manage profit & loss.
Designing the costume or perfect roti,
Geometry is natural, that’s our beauty.
Collecting the pieces of our broken heart,
Integration never seemed less than a beautiful art.
Graphs are like minions of our lives,
Shows us the ups and downs it hides.
Look around, mathematics is everywhere,
We do it or not, why do you care?
All we have learnt is to follow our passion,
Girls can do maths, clear your confusion.
We savoured every star in the sky,
We don’t fear challenges, our ambitions are high.
Mathematics is not a hype,
Who said it’s not our type?

-Soumya Srivastava
1st Year

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One man can be a crucial ingredient on a team, but one man cannot make a team.

-Kareem Abdul-Jabbar