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Department Farewell

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From the Editors Desk

For every one *Trapezium* - is just a quadrilateral with one pair of sides parallel. But for us, it is a platform or an opportunity to express ourselves to the dear world. Just as every other year we - the family members of Dept. of Mathematics in B. Borooah College are happy to present our annual magazine to the readers.

Though the process changed a bit this year, considering the prevailing Covid-19 situation. We were bound to move on to connect and complete this whole process virtually. But we highly appreciate the support from out mates and advisors, that made this journey a fruitful one.

We believe, readers will love this volume of *Trapezium*. As well, we would love to hear back from them to continue this journey in the upcoming days.

As the editors, we feel proud to get this chance and would like to thank each one, who have contributed or helped us in getting this prepared. Especially, we would thank our teachers for their support and guidance throughout the process.

Hirak Jyoti Sharma
Sofikul Islam
Editors

Fractal Geometry : An Introduction

Dr Anjana Bhattacharya
HoD & Associate Professor
Department of Mathematics

What do the following have in common:

- a galaxy, a coastline, a lung, a tree
- a figure which changes its shape, the closer you look at it
- a figure that looks the same at any scale
- a figure which has dimension in between two and three
- a figure which is self similar in nature i. e. the constituent parts are identical to the whole pattern.

The answer is- all are related to the magic of fractal.

The word fractal is originated from the Latin word fractus-which means fragmented and irregular.

A fractal is a rough or fragmented geometrical shape or pattern that can be subdivided in parts each of which is a reduced size copy of the overall pattern. The study of the fractals is the fractal geometry. This whole new branch of geometry was first developed by an IBM scientist and Professor of Mathematics at Yale Benoit Mandelbrot in 1975. Some prior mathematical thinkers like Cantor, Hansdorff, Julia, Koch, Peano, Poincare, Sierpinski etc. had attained isolated insights of fractal understanding, but their work was quite ignored at that time. Benoit Mandelbrot is the first to explain the concept underlying fractal geometry through his seminal work-"The fractal geometry of nature".

The traditional Euclidean or classical geometry, which is familiar to all of us, deals with straight lines, polygons, circles and other shapes and objects. It has served us for centuries in the development of science and technology. But it can describe things and objects, almost non-existent in nature. In reality Euclidean geometry fails to describe the natural objects around us like cloud, mountain, a coastline or a tree. Before Mandelbrot mathematicians used to believe that most of the patterns of nature were far too complex, irregular, fragmented and amorphous and could not describe mathematically. But fractal geometry is the geometry of nature with which we can describe and mimic nature in a way which is not possible before. Fractal geometry help us to visually model the natural objects like coastline, mountain, snowflake etc. It can also be used to model soil erosion and to analyse seismic patterns.

Method : The numerical methods used to produce fractals are not so difficult. Fractal images are produced by graphical representation of points obtained from some simple mathematical equations performing iterations a million of times.

The computations and display of results are done with the help of computer and computer graphics.

The method used is the Newton's method of iteration, which is used generally to solve higher degree equations. To iterate a given function, an approximate solution is taken. Then a better approximation is obtained by putting the last answer back to the equation. The process is repeated until the answer does not change-that being a solution. Similarly different starting value is taken for other roots, and if lucky the formula converge to an alternative solution.

The boundary between the range of values converging on one root and those converging on another is a fractal curve.

Let us now discuss the most famous fractal image of the Mandelbrot set.

How to build the Mandelbrot set :

The Mandelbrot set is the set of all points which remains bounded for every iteration of $f(Z)=Z^2 + C$ on the complex plane, where initial value of Z is 0 and C is a constant. To create the fractal image of the Mandelbrot set, we have to separate the points of the entire two dimensional complex plane into two categories :

Points inside the Mandelbrot set

Points outside the Mandelbrot set

If we take a point C on the complex plane, it will be of the form X +iY. If Z=0 is taken as starting point the value of Z^2+C. the point Z=0 is the critical point where $d/dz\,(Z^2+C)=0$. on repeating the same calculation taking Z=C, the next result will be C^2+C. thus if iteration is done repeatedly for the function Z^2+C, a sequence numbers will be obtained for initial point C. this sequence of numbers is called orbit of C. now this orbit may remain new to the origin or may go away, increasing its distance from origin. In the first case the point C is said to belong to the Mandelbrot set and otherwise it is said to go to infinity. But it is impossible to iterate the function an infinite number times to see whether a point belongs to the Mandelbrot set or not. It can be easily shown that if the distance of the point from origin becomes greater than 2, it will grow without limit. Therefore if the distance of the point from origin is just greater than two, we stop the iteration and conclude that the point will go to infinity.

On the other hand, if a point belongs to the Mandelbrot set it's distance from origin will never greater than two, no matter how many iterations is performed. In that case, we set a maximum number of iterations. The more number of iterations we use, the more clear and

detailed picture we will get. For example take the point C=-0.5+i. Iterating the function Z^2+C will produce the following values:

Step	Current Value	Distance from the origin
1	-0.5+i	1.12
2	-1.25	1.25
3	1.06+i	1.46
4	-0.37+3.1i	3.15

At the third iteration, the distance of the point from origin becomes greater than 2. this means that initial point C does not belong to the Mandelbrot set. Let us repeat the same process for the point C=0.2+i0.5. in this case the distance of the point from origin never becomes greater than 2. After performing a maximum number of iterations (for example 200) we can conclude that the initial point C belong to the Mandelbrot set. The list of numbers obtained in this case are:

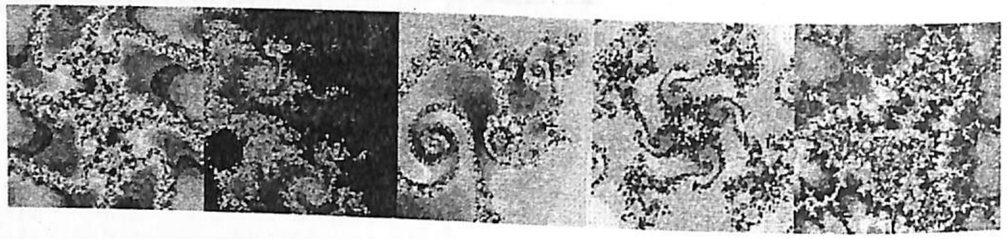
Step	Current value	Distance from the origin
1	0.2+I*0.5	0.54
2	-0.01+I*0.7	0.7
3	-0.27+I*0.49	0.57
4	0.05+I*0.22	0.22
5	0.15+I*0.52	0.54
6	-0.05+I*0.66	0.66
7	-0.23+I*0.44	0.48
	....	....

How to produce the Fractal image of the Mandelbrot set :

To produce the fractal image of the Mandelbrot set we have to consider each and every point (x, y) in the complex plane and colour them accordingly. If the point (x, y) belong to the Mandelbrot set, we colour it blue. If the point (x, y) goes to infinity, we colour it according to how quickly it exceeds the number. Some colour is assigned to the points which take same number of iterations to reveal that it is attracted by infinite.

On doing so for every point (x, y) we will have a normal picture of the Mandelbrot set as below:

The fractal boundary is the edge between the central blue sea and the rest of the picture. Some other fractal images are shown below:



Conclusion :

Mandelbrot's discovery of fractal geometry is treated as one of the greatest discovery in twentieth century mathematics.

Scientists now have begun to investigate the fractal character of wide range of phenomenon.

The most effected discipline of science by fractal geometry is Physics.

For example in condensed matter or solid state physics, the percolation cluster model used to describe critical phenomenon involved in phase transitions and in mixture of atoms with opposing properties is clearly fractal.

In mathematical physics for dynamical systems, which changes their behaviour over time-become chaotic and totally unpredictable-physicists try to describe their routes by using fractals. In biology, the anomalous thermal relaxation rate of iron containing proteins has been explained as resulting from the fractal shape of the linear. Polymer chain that comprises all proteins. Fractal forms are also found in the body. The best known example are the arteries and veins in mammalian vascular system.

Chotician Michael Mc Guire on his recent discoveries in brain research suggests that the receptive fields of the visual cortex are organized in fractal form based on hexagons.

More research is going on in the biological fields. Finally on the interface of science and art, computer graphics specialists, using recursive splitting technique, have produced striking new fractal images. Landscapes made this way have been used as backgrounds in many motion pictures; trees and other branching structures have been used in still lives and animations.

Above all, fractal geometry breaks the classical tradition that mathematics is a body of sterile formulae. It mixes art and mathematics to show that mathematical equations are more than just a collection of numbers. But beyond all, its visual beauty can help to alter student's beliefs that mathematics is dry and inaccessible and motivate them towards mathematical discoveries.

Ramanujan's 'The Most Beautiful Identity'

Hirak Jyoti Das
Ex-Student, (2012-15 Batch)

I want to take the freedom of not introducing Srinivasa Ramanujan (1887 - 1920) to you, because I believe the name of Ramanujan can't go unheard by anyone. People, who have atleast peeked into his fields always tend to think, 'He would surely have given a lot more, if . . . .' Freeman Dyson (1923 - 2020), a great physicist and mathematician had his words as

"The wonderful thing about Ramanujan is that he discovered so much, and yet left so much more in his garden for other people to discover. For forty-four years I have intermittently come back to Ramanujan's garden; and every time when I come back, I find fresh flowers blooming."

Now it has been a century since the time of Ramanujan and his genius is still pushing the curious minds in search of new knowledge. If you step in for the data of the number of brilliant active researchers in number theory in the spirit of Ramanujan, you will be surprised by a big number.

Anyway, we don't go to Ramanujan's biography here. Instead, we recollect some wonderful mathematics that Ramanujan was interested in. To do that, we need to start with something called partitions of positive integers.

A partition of a positive integer n is a finite non-increasing sequence $\lambda := (\lambda_1, \lambda_2 ......\lambda_k)$ of positive integers such that $\sum_{j=1}^{k} \lambda_j = n$ We call $\lambda_j's$ the parts of the partition λ.

Let's take an example when n = 4. Quite obviously we see that the partitions of 4 are (4), (3, 1), (2, 2), (2, 1, 1), and (1, 1, 1, 1). Similarly, there are 30 and 135 partitions for 9 and 14 respectively and so on. But interestingly, these numbers of partitions for 4, 9, 14,. . . are following a certain feature. It is almost obvious to everyone who does a bit of reasoning. The story of Ramanujan's 'The Most Beautiful Identity' started right here. Ramanujan had also noticed the key feature about those numbers of partitions which led him and subsequently the next generations to the field of *generating functions* for the number of partitions.

Let's call-on the story. We first move back to one of the greatest mathematicians, Leonhard Euler (1707 - 1783). Let's look at the series expansion of 1/(1 - q) where | q |< 1

$$\frac{1}{1-q} = (1 + q + q^2 + q^3 + ...)$$

which we are interested in writing as

$$\frac{1}{1-q} = (1+q^1 + q^{1+1} + q^{1+1+1} + ...)$$

Now, look at the following product

$$\prod_{j=1}^{\infty}\frac{1}{1-q^j} = (1 + q^1 + q^{1+1} + q^{1+1+1}+...)\,(1+q^2+q^{2+2}+q^{2+2+2}+ ...)$$

If you try to pluck out the power 4 of q from the above, how many of them are going to be extracted and what are they? They are very simple. First you will pluck out q^4, the next one seems to be q^{3+1} followed by q^{2+2}, q^{2+1+1}, and $q^{1+1+1+1}$. Well, everything is coming our way now. In this process you have extracted 5 powers of q which are 4, and they are simply 4, 3 + 1, 2 + 2, 2 + 1 + 1, and 1 + 1 + 1 + 1. These sums are special, because they form the partitions of 4. Thus if we call p(n), the number of partitions of n, we have p(4) = 5 and

$$\sum_{n=0}^{\infty} p(n)q^n = \prod_{j=1}^{\infty}\frac{1}{1-q^j}$$

This is the generating function of the number of partitions p(n), given by Euler. But the study of partitions intensively started in Cambridge, England after more than one hundred and a fifty years after Euler. Euler had also shown that

$$\prod_{j=1}^{\infty}(1-q^j) = 1 - q - q^2 + q^5 + q^7 - q^{12} - q^{15} + ...$$

The powers, 1, 2, 5, 7, 12, 15,. . . are known as the pentagonal numbers. Meanwhile, we are ready to enter the second decade of the twentieth century.

Percy Alexander MacMahon (Major MacMahon, 1854 - 1929), who served at Madras, Lucknow and Punjab under the British empire in India, returned to England in early 1878 and a sequence of events began which led to him becoming a mathematician rather than a soldier. He was an expert in enumerative combinatorics. Now it's time to tell Ramanujan's story.

Ramanujan, at first was reluctant to go to Cambridge at the invitation of Godfrey Harold Hardy (1877 - 1947), although the invitation came after Ramanujan's papers had been re turned without comment by Henry Frederick Baker (1866 - 1956) and Ernest William Hobson (1856 - 1933) earlier. But after Eric Harold Neville (1889 - 1961) had urged Ramanujan on behalf of Hardy, he was ready to sail to England.

Now back to our main story. We have that the partition generating function is the recip rocal of the above series. This implies

p (0) = 1,
p(1) – p(0) = 0,
p(2) – p(1) – p(0) = 0,
p(3) – p(2) – p(1) = 0,
and, more generally, for n > 0,
p(n) – p(n – 1) – p(n – 2) + p(n – 5) + p(n – 7) – – + + · · · = 0

For each n, the sum on the left terminates, since all terms with negative argument are zero. MacMahon, who was in Cambridge with Hardy and Ramanujan, used the above recurrence to calculate p(n) for n ≤ 200, and serendipitously listed the values in groups of five thus:

1	7	42	176	627	1958	...
1	11	56	231	792	2436	...
2	15	77	297	1002	3010	...
3	22	101	385	1255	3718	...
5	30	135	490	1575	4565	...

Ramanujan observed that the numbers at the bottom of each group are divisible by 5, that is, 5 | p(5n + 4). He also observed that 7 | p(7n + 5), 11 | p(11n + 6), and, on the basis of the very small amount of evidence provided by MacMahon's table, formulated a very general conjecture, which was essentially correct. Ramanujan did much more than proving 5 | p(5n+4). He claimed the generating function of p(5n + 4) to be

$$\sum_{n=0}^{\infty} p\,(5n+4)q^n = 5\prod_{j=1}^{\infty}\frac{(1-q^{5j})^5}{(1-q^j)^6}$$

"It would be difficult to find more beautiful formulae than the 'Rogers-Ramanujan' identities, but here Ramanujan must take second place to Rogers; and, if I had to select one formula from all Ramanujan's work, I would agree with Major MacMahon in selecting (1). Hence, I refer to (1) as "Ramanujan's most beautiful identity."

This is the end of our story which is a small fraction of the great mathematical saga of Ramanujan's work. The legacy of Ramanujan always continues.

Why do Real Analysis?

Nijara Konch
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In undergraduate level mathematics honours classes, excluding a handful of earnest students, real analysis is viewed as one of the difficult course to learn. There may be two primary reasons- firstly the abstract concept that is being encountered by students for the first time which also demands rigorous proofs; secondly the lack of pedagogical exposure to make them learn the art of abstract reasoning to understand things from intuition. As a consequence, mere memorizing and vague absorbing habit adopted by students to learn the course make it even harder.

Real analysis is the analysis of real numbers and objects formed from it viz. sequence and series, real valued functions etc. Therefore, it is a prerequisite that students are well acquainted with the rigorous construction of the three fundamental number systems: the natural number system N, the integers Z and the rationals Q (here the symbols N and Q stand for 'natural' and 'quotient'. Z stands for 'Zahlen', the German word for 'numbers') prior to the reals ?. It is also assumed that students are capable of building up basic properties (say ordering property, algebraic property etc.) of these number systems of their own and are able to subjugate underlying theories rather than merely computing it mathematically.

The existence of natural numbers is defined using Peano axioms which corresponds to the very intuitive and fundamental notion of 'sequential counting'. But the limitations of these numbers beyond operations addition and multiplication paved the way to construct a larger system i.e. integers by introducing the operation subtraction. Similarly rational numbers were constructed by taking quotients of integers (excluding division by zero to keep the laws of algebra reasonable) i.e. by introducing another operation division over integers. But to explore the gap in rationals (that can be visualised as interspersing of integers by rationals and interspersing of rationals by rationals), the concept of a somewhat new notion'limit' arrived to fill the gap using which one can pass from a 'discrete system' to 'continuous system'. Therefore ? contains rational numbers with a new limiting operation of the type 'supremum' or 'infimum'. The procedure of obtaining real numbers from rationals as limits of Cauchy sequences of rational numbers can be regarded as one of the finest constructive method in analysis. Hence a

real number can be defined as an object of the form $\lim_{n\to\alpha} a_n$ where, $(a_n)_{n=1}^{\alpha}$ is a Cauchy sequence (an eventual $\in$- steady sequence[1]) of rational numbers. And two real numbers $\lim_{n\to\alpha} a_n$ and $\lim_{n\to\alpha} b_n$ are said to be equal if and only if $(a_n)_{n=1}^{\alpha}$ and $(b_n)_{n=1}^{\alpha}$ are equivalent Cauchy sequences (i.e. $(a_n)_{n=1}^{\alpha}$ is Cauchy if and only if $(b_n)_{n=1}^{\alpha}$ is Cauchy). Here well- defineness and other usual arithmetic properties of real numbers are defined and validated from sequential perspective.

One question that often bothers the students is 'why do analysis'? Are rules and formulae in calculus not adequate to solve problems? Answers is 'yes'. But without knowing why these works, where they came from, what are the limits of applicability as well as exceptional cases (if any) may put one into trouble. For example, let us consider the infinite sum

$$S = 1 + \frac{1}{2} + \frac{1}{4} + \frac{1}{8} + \ldots$$

Then, $2S = 2 + 1 + \frac{1}{2} + \frac{1}{4} + \frac{1}{8} + \ldots \Rightarrow 2S = 2 + S = 2.$ Therefore, applying this particular trick to this problem, we obtain the infinite sum equal to 2. However, if we apply the same trick to the series

S=1+2+4+8+...

We get, 2S=2+4+8+...$\Rightarrow$ 2S = S-1 $\Rightarrow$ S = -1. i.e., the infinite sum of positive terms results a negative value which is definitely nonsensical. There are ample such examples of dilemma. Therefore justifying such rules are of outmost importance which is dealt by analysis. Moreover, analysis help one to develop 'analytical way of thinking' through which one can place and modify the standard rules in a wider context or different frame viz. when dealing with complex valued functions instead of real valued functions, how to work in a spherical frame instead of a plane etc. Over course of time, it will actually develop of sense how to adapt to a new situation logically and analytically. That is why analysis of real numbers is fundamental in mathematics.

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1. A sequence $(a_n)_{n=1}^{\alpha}$ is said to be eventual $\in$- steady if and only if there exist a natural number N such that $|a_j - a_k| \le \in$ for all j, k $\ge$N.

(Courtesy: Analysis I (Third Edition) by Terence Tao)

Music, Poetry, and Journey of Fields Medalist Manjul Bhargava

Hirak Jyoti Das
Ex-Student (2014 -17 Batch)

A lot of the time, when you do the math, you're stuck. But you feel privileged to work with it -you have a feeling of transcendence and feel like you've been part of something really meaningful.......(Akshay Venkatesh, Fields Medal winner)

The Fields Medal is regarded as one of the highest honors a mathematician can receive and has been described as the mathematician's Nobel Prize. The Fields Medal also has an age limit: a recipient must be under age 40 on 1 January of the year in which the medal is awarded.

Manjul Bhargava, the first Indian-origin mathematician to win the coveted Fields Medal. He said that the inspiration behind his discoveries in number theory has been the classic works of ancient Indian mathematicians. The classic works of Pingala, Hemachandra, and Brahmagupta have been particularly influential in his work.

In part because of the scientific nature of the Sanskrit language, many remarkable linguistic/poetic/mathematical works were written in ancient times in India. Growing up, he had a chance to read some of the works of the masters: the great linguists/poets such as Panini, Pingala, and Hemachandra, as well as the great mathematicians Aryabhata, Bhaskara, and of course Brahmagupta. Their works contain incredible mathematical discoveries, and were very inspirational to him as a young mathematician.

His grandfather was a renowned scholar of Sanskrit and ancient Indian history, and his mother, a mathematician with strong interests also in music and linguistics. As a result, he also developed deep interests in language and literature, particularly Sanskrit poetry, and in classical Indian music. He learned to play a number of musical instruments, such as sitar, guitar, violin, and keyboard. But he always enjoyed rhythm and percussion the most! His favorite instrument was the tabla. He enjoyed thinking about the mathematics of rhythm in classic Hindustani and Carnatic music.

While growing up, he learned from his grandfather how much incredible mathematics was discovered in ancient times by scholars who considered themselves not mathematicians, but poets (or linguists). Linguists such as Panini, Pingala, Hemachandra, and Narayana discovered some wonderful and deep mathematical concepts while studying poetry.

Here is an example, originating in 500 B.C., that has been particularly fascinating to him as a drummer.

In the rhythms of Sanskrit poetry, there are two kinds of syllables - long and short. A long syllable lasts two beats, and a short syllable lasts one beat. A question that naturally arose for ancient poets was: how many rhythms can one construct with exactly (say) eight beats, consisting of long and short syllables? For instance, one can take long-long-long-long, or short-short-short-long-long-short.

The answer was discovered by the ancients and is contained in Pingala's classical work Chandashastra.

Here is an elegant solution. We write down a sequence of numbers as follows. We first write down the numbers 1 and 2.

And then each subsequent number is obtained by adding up the two previous numbers. for example, we start with 1 and 2, and then 1+2 is 3, so we have so far 1 2 3. The next number is obtained by adding up the last two numbers 2 and 3, which is 5. So we have so far 1 2 3 5. The next number written is then 3+5 which is 8. In this way, we get a sequence of numbers 1 2 3 5 8 13 21 34 55 89... The n-th number is written tells you the total number of rhythms, consisting of long and short syllables, having n beats. So for 8 beats, the answer is that there are 34 such rhythms in total.

This sequence of numbers is now ubiquitous in mathematics, as well as in a number of other arts and sciences! The numbers are known as the Hemachandra numbers. The numbers are also known as the Fibonacci numbers. These numbers play an important role now in so many areas of mathematics. They also arise in botany and biology. For example, the number of petals on a daisy tends to be one of these Hemachandra numbers.

This story inspired him when he was growing up because it is a wonderful example of a simple idea that grew into something so omnipresent, important, and deep-unraveling surprising and beautiful connections among different realms of thought.

I don't have any particular recipe [for developing new proofs] ... It is like being lost in a jungle and trying to use all the knowledge that you can gather to come up with some new tricks, and with some luck, you might find a way out.....(Maryam Mirzakhani, the only woman and the first Iranian to be honored with Fields Medal who died of breast cancer at the age of 40)

Mystery behind Physical Constants

Kuldeep Sarma
PhD Scholar
Department of Mathematical Sciences, Tezpur University

Scientific progress has explained many of the physical phenomena. But the awe in the finely tuned workings of the universe will remain. A sunset has lost none of its magnificent beauty, even though we may now explain that what paints the sky red each evening is nothing but the preferential scattering of the blue end of the visible light spectrum and greater penetrating power of the longer red wave lengths that pushes the red photons of light through the atmosphere to our eyes.

Physicists explain that the physical constants of our universe like, the speed of light, Planck's constant, the gravitational constant, etc., are unique. If the value of these physical constants had been slightly different , the universe would have been very different . Even the electrons and the protons are arranged in such a way that nature is very fine tuned. Explaining the mystery in the precision of masses of electrons, protons and neutrons, Prof. George Wald, a Nobel Laureate in Physiology or Medicine from Harvard University states, "The great disparity in mass between nucleons and the electrons is one of the necessary conditions for life. Almost the entire mass of an atom is in the nucleus and it is thought to maintain its position regardless of how the electrons are moving about it. That is the only reason why anything in the universe stays put. If the protons and neutrons were close in mass to the electrons-whether light or heavy they would rotate around one another (about their common centre of mass) and all the matter in the universe would be fluid".

Then existence of four fundamental forces-gravity, electromagnetic force and strong and weak nuclear forces, which are said to help us to have user-friendly universe filled with order and stability, is a great mystery. For example, gravity. If we hold a heavy object out at arm's length, we feel the downward pull. What is causing this pull? We say, gravity. But what produces gravity? We may then say, gravitons. But what are gravitons? We do not know. It is totally imperceptible.

Similarly, both the magnetic and the electromagnetic forces are theoretically carried by a single type of entity, photons, which is totally invisible and massless, observed only in their effects, as iron is drawn to a magnet. But what exactly produces the photon in the magnet that reaches out to the iron, or in the nucleus of an atom that sends it hurtling off toward the orbiting cloud of electrons? Perhaps we are encountering the mysterious subtlety hidden beyond the physical.

Simulated Reality

Rownak Kundu
Ex-Student (2013-16 Batch)

Many of you might be familiar with the movie Matrix. Based on simulated reality, the movie depicts a dystopian future in which reality as perceived by most humans is actually a simulation called "The Matrix? created by sentient machines to subdue human population, while their bodies? heat and electrical activity are used as their source of energy.

In recent years, the idea of simulated reality has gain such a momentum that investors of the likes of Elon Musk has been rumoured to fund for its research. Even physicist, Neil de Grasse Tyson was once quoted saying, " The odds are at 50-50 that our entire existence is a program on someone else's hard drive".

Simulated reality is a hypothesis that reality could be simulated to a degree indistinguishable from true reality. The simulated reality imitates the real world and exists as a distortion inside the human mind. The concept of simulated reality rests on older concepts such as solipsism and the conundrum is that we can never really know if our senses and memories are mere illusions. In a paper published in 2003 by Nick Bostrom, a trans humanist philosopher, he argues that the simulated reality argument is, in fact, correct and that the world that we see around us is very likely to be a computer simulation. The paper begins by arguing that at least one of the following propositions must be true -

- The human species is very likely to go extinct before reaching a post human stage.
- Any post human civilisation is extremely unlikely to run a significant number of simulations of their evolutionary history.
- We are almost certainly living in a computer simulation.

The paper then goes on arguing that there is a significant chance that we will, one day, become post-human who runs ancestor simulations, therefore, it is almost certain that we are living in a computer simulation. Since, 2003 there has been a lot interest in the idea, especially with the online community.

While the argument regarding simulations is a twisted view of reality, and proposes an interesting question regarding nature and technology, there has not been any evidential proof regarding the same. The difference between simulated and non-simulated reality also seems to moot depending on one's perception about what is real and what is not. Simulated reality is used mere as a thought experiment or a narrative twist in fiction, rather than a theory that any body genuinely believes in.

Letter to Ramanujan

Purbasha Bharadwaj
2nd Sem., Department of Mathematics

Dear Ramanujan Sir,

It's been decades since you left us, I would say it was one of the most unfortunate demise of all times. You were a gem to the world of Mathematics. But for now I am much glad to get a chance to speak my heart out to you through this letter.

When I look through your extensive inventories, though I have not had access to most of them till now, yet, the few I know are so brilliant like the '*Divergent Series*', '*Rama – Satoseries*' and most importantly the " *Hardy – Ramanujan – Rademacher'sasymptotic formula*"—the groundbreaking discovery of your time. Learning about your life, the amount of rejection and other obstacles you faced surprise and at the same time inspired and motivated me because you never gave up. I can't believe someone can even reject those 'Priceless' pieces of theories and equations you formed yourself just because you lacked a degree. I don't know how you were able to pull off those theories at such an early age even without a complete mathematical knowledge. I am glad Professor Hardly acknowledge your works and brought them to every one of us. You have no idea how much I admire Mr. Hardy for his care and dedication towards you. How he tried to provide you the foundational degree without making you lose your self confidence. Inspite of having such a poor financial condition, you never got disheartened. I read that initially you wrote your theories and equations in the temple floor just because you couldn't afford paper and ink. I consider myself lucky that I didn't have to face such obstacles like you did. All those religious barriers you had to face, it must have been so difficult.

I read about the incident of you and Prof. Hardy. *The taxi number 1729*! He told it's a dull number. But you found an interesting way of dealing with it as the smallest number to be expressed as cube of two different numbers in two different ways. I was astonished as to how you came to that so fast. Later I got to know about the number theory you invented related to this. And you know, this number is now named after you. **"1729: the Ramanujan Number".**

I recently watched your biopic and I had so many questions in my mind. How did all those theories and equations came to your mind, when all the degree holder professors of that time couldn't understand most. You once told Mr. Hardy that an equation means nothing to you unless it expresses a thought of God. I had to ask was there any theory you think didn't express such thoughts? What if that's a famous proven theory. Will you approve of that? I saw

there how you were underestimated and discriminated just because you were an Indian. I am glad they got to know what you were capable of. You deserved every ounce of praise and applause.

We will always be thankful to you for your contribution to math as your theories are being used for futuristic ideas like signal and spring theory. I was so amazed and proud to know that some of your theories are being used to study the black hole. How did you do that! These are such recent discoveries; people at your time had no idea about them.

It's puzzling how you came to these findings. Maybe Goddess Namagiri was always by your side. You have added a new feather of success in the crown of mathematics. Your life and way of living is a roadmap for every person chasing success in an honest and diligent way. You are legend. As promised by Mr. Hardy, even if you left, your work will live till eternity. You are and will always be remembered as

"RAMANUJAN: THE MAN WHO KNEW INFINITY AND BEYOND"

THE FIELDS MEDAL

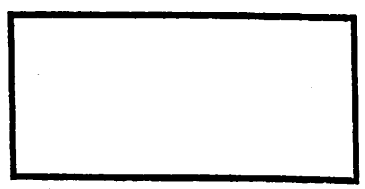
The fields medal is one of the most recognize prizes give to mathematicians who have achieved something great during their career. The official title for this prize is the international medal for outstanding discoveries in mathematics and it is given out once every four years to up to four Mathematicians under the age of 40.The prize is given at the International Congress of the International Mathematical Union which is only held every four years and it is the most prestigious medal in the field of mathematics.

History of Calculus

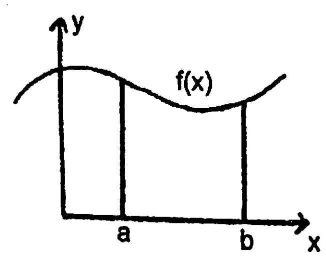
Partha Pratim Das
4th Sem., Department of Mathematics

Calculus, known in its early history as infinitesimal calculus, is a mathematical discipline focused on limits, continuity, derivative and infinite series.

Calculus was then came to development as there was something about curvature that specially required some extra technique, such as the area of a rectangle was easily calculated because the distance between opposite side is fixed, but when a value such as the height of a figure is changing from one point to the next, the technique of algebra and geometry didn't work any longer and something more sophisticated was needed.



Rectangle

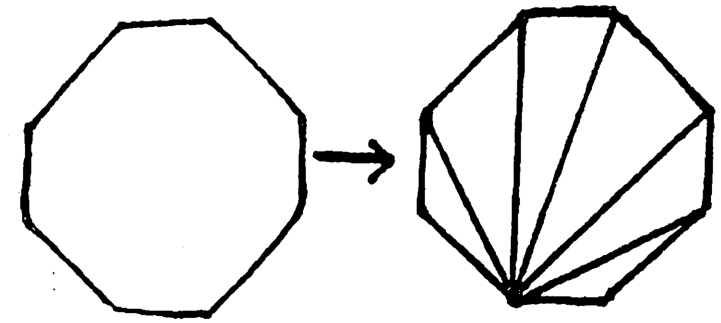


Area under curve

During the 17th century this sophisticated branch of mathematics finally came about. The first to make considerable progress, but everything came together with Isaac Newton, who along with Gottfried Leibnitz credited with developing modern calculus.

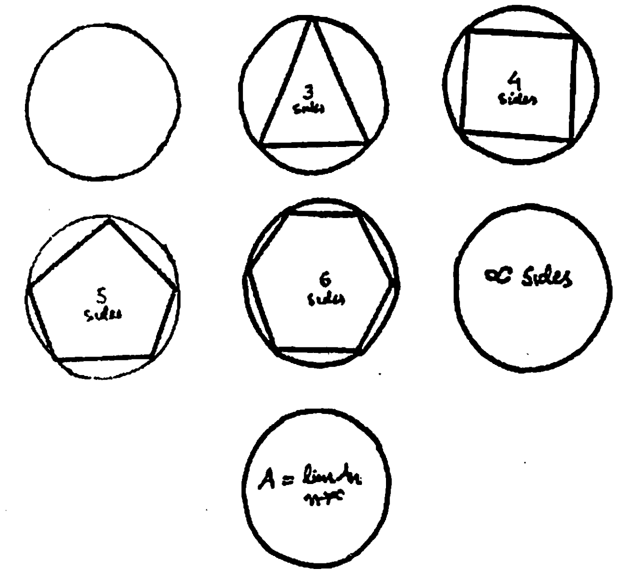
Talking about the pioneer of calculus starting from 17th century. The ancient period introduced some ideas of integral calculus for calculation of volumes, area by the Egyptian but not in a rigorous and systematic way and later some more was added by the Babylonians who discovered trapezoidal rule while doing astronomical observation of Jupiter.

From the age of Greek mathematics Exodus, they were able to prove area of shape through method of Exhaustion for normal polygon, say an octagon when they split it up into a number of triangle and find the area of the polygon by adding area of each triangle.



Dividing an octagon into Number of triangles to get its area

But circles were special since they can't directly be split into triangle so they inscribed a polygon and gradually increased the number of sides so that area of the circle would approximately be equal to the area of the polygon but the area of the circle would only be same as the inscribed polygon with infinite sides from this we get the concept of limit and it incorporated the idea of the infinite process, while Archimedesdeveloped this idea further by resembling the methods of integral calculus.



On the Medieval era, one of the greatestmathematicalastronomers who contributed to calculus was Madhava who linked the idea of infinite series with geometry and trigonometry. He was able to formulate infinite series expansion for sine, cosine, arctan and even π which was utilized more later to form the concept of calculus.

Coming to the Modern Era, where calculus got formed and its discovery is often attributed to two men Isaac Newton and Gottfried Leibnitz who independently developed its foundation. Although they were instrumental in its creation, they thought of fundamental concept was in different ways. Newton came to calculus as part of his investigation in physics and geometry. He viewed calculus as the scientific description of the generation of motion and magnitude. In comparison, Leibnitz focused on the tangent problem and came to believe that calculus was a metaphysical explanation of change.

Sir Issac Newton

Gottfried Leibniz

Newton developed calculus simply out of necessity in order to hove tools he needed to solve problems in physics regarding celestialmotion. He realized that if we drop an object its speed will increase every single instant until it hits the ground. But during the time the object must have some definite speed at any given instant. He knew of no mathematics that would adequately calculate instantaneousvelocity as something has to be development that could describe the difference between the value of a function. So, this concept of rate of change was the important path that bought the mathematical revolution towards the development of differential calculus.

Leibnitz knew that $\frac{dy}{dx}$ gives the tangent but he didn't use it as defining property, on the other hand, Newton used quantities x and y. It is interesting to note that Leibnitz was very conscious of the importance of good notation and put a lot thought into the symbol he used. Leibnitz notation was better suited to generalizing calculus to multiple variables and in addition it highlighted the operational aspect of the derivatives and integral. As a result, much of the motivation that is used in calculus today is due to Leibnitz such as '$\int dx$' for the integral and for derivative of a function y of the variable x.

Rate of change problems ↓ Differential Calculus	Area under a curve problems ↓ Integral Calculus

Differential Calculus	Integral Calculus

- We can do something infinitely many times and get a finite answer
- Involves things that are infinitely small or are infinitely close together.

Newton-Leibnitz Controversy was a rift in the mathematical community lasting ancentury. Leibnitz was the first to publish his investigation, however it was well established that Newton has started his work several years prior to Leibnitz.Today both Newton and Leibnitz are given credit for independently developing the basis of calculus.It is Leibnitz however who is credited with giving the new discipline the name it is known by today 'Calculus'.

WOLF PRIZE IN MATHEMATICS

The Wolf foundation of Israel awards six different prizes each year and one of them is the wolf prize in mathematics. This prize has been awarded since 1978 and it is also a prestigious honor to receive one in the fields in which they are given. Some of the recent recipients of The wolf prize in mathematics include Peter Sarnak, Michael artin, George D. Mostow, Luis Caffarelli and Micheal Aschbacher.

Vedic Mathematics : It's Contextuality in recent times

Hirak Jyoti Sharma
4th Sem., Department of Mathematics

Vedic mathematics - yes, unfortunately till date we generalize this core subject as just a set of some shortcut tricks to do our general arithmetic operations, but factually it has a lot more within. The same segment of mathematics has often fascinated many mathematicians and renowned scholars of all time.

This name actually originates from the Sanskrit word 'Veda' which means 'Knowledge'. It is believed that this system of mathematics was discovered by an Indian mathematician-Jagadguru S hri Bharathi Krishna Tirthaji in the period between A.D. 1911 and 1918. As said, he was an avid reader and a great researcher of that time. He went into deep meditations and studied the four Vedas extensively and discovered these sutras (formulae) lying hidden in the verses of Atharva Veda.

Originally, his findings consisted 16 sutras and 13 sub-sutras (sub-formulae) which can be used for solving problems in arithmetic, algebra, geometry, calculus, conics etc. But with time, many scholars have studied the same and implemented it in the modern - day problems, hereby developing many more sets of applications in today's date in the fields of Mathematics, Physics and other disciplines.

We can simply define it as a collection of these techniques or sutras that help us to solve mathematical problems in an easy and faster way. Many a times, using regular methods for solving a mathematical problem takes enough time, as well involvescomplexity. But with Vedic math, its general principles and specific techniques associated with that set of data, the same numerical can be solved more efficiently.

Coming to its benefits, it is cent percent clear that we can do a numerical using Vedic mathematics many times faster than normal math. It increases our speed and accuracy, which can surely help us in improving our performance and to get instant results. As it involves good brain exercise, it sharpens our mind, increases our mental ability and intelligence. Also it increases our visualization and concentration as a child. And accordingly, it will make us a mental calculator.

Of course, as everything else, Vedicmath too has its negative side. As here the general rules are meant for certain type of problems, in a whole to use Vedic mathematics, we have to learn many rules, that will often create confusion. Also, in many cases, it requires a good amount of mental effort, that may not be possible for each one of us. And interestingly, we will not be allowed to write examinations using Vedic mathematics.

Today, we can gather up hundreds of books and good publications made available by different writers in the last decades, and learn Vedic Mathematics, its techniques, and implementations in our daily problems. However, they all are based on the book by Tirthaji, which was first published in 1965. The book had forty chapters in its 367 pages.

In recent years, there have been many organizations and set-up that promotesVedic mathematics and works on behalf to represent it in both local and global platforms. Thiseffort has surely created a general awareness regarding the subject and its great significance. But, such a segment of knowledge surely deserves to be known to every one and a lot more practitioners.

It is quite obvious that mathematics was, or never will be a cup of tea for each one of us. But notably, with just few skills in this field, many ones have succeeded to be in a limelight. And it will only be possible if we go along Swami Vivekananda's advice : "Back to Vedas".

Even our Government has now intensified that just to be good in regular studies is never enough. The newly proposed National Education Policy-2020 has a lot of focus on the vocational subjects, its trainings and degree opportunities, so that we become more accountable to career options than before, which clearly indicates our need to be more efficient.

Here, in the same line, if our Govt. takes a step and prescribes Vedic Mathematics too in the new study curriculum, then it is quite sure that more hundreds of students will eagerly have the same tea. What it means, is that every child deserves a chance to know about Vedic Mathematics, a golden gift from our ancestors. At all, they should take the benefits of Vedic mathematics and should have fun in doing and learning mathematics. Hence it is rightly said, **"if mathematics is the queen of all sciences, then surely Vedic mathematics is the way to that kingdom."**

Arithmetic and Philosophia

Bhrigu Das
4th Sem., Department of Mathematics

"Mathematics is the queen of the sciences- and number theory is the queen of Mathematics." – **Carl Friedrich Gauss**

'The title is too classical, I guess !' don't worry I am not here to make you read tough words, or words our brain can even digest.

'The reader' I will be directly pointing with 'you' so don't get confused. You must be familiar with the word 'Arithmetic' (a branch of mathematics that deals usually with the non-negative real numbers including sometimes the transfinite cardinals and with the application of operations of addition, subtraction, multiplication, and division of them). Modernly known as Number Theory, a branch of pure mathematics devoted primarily to the study of the integers and integer-valued functions. You must have seen some of the definition earlier and I am not here writing about "Why do we need number theory ?", "What are different subfields of number theory ?", or "What are it's application?".

It's all up to you, magic of mathematics is waiting to be explored! one can relate it to treasure hunting or looking for a mystery to solve. You can think your way, learning is fun after all.

Uh-huh ! As I mentioned 'FUN', Are you familiar with 'Philosophia?' It means 'love of wisdom' and is the study of general and fundamental questions, such as those about reason, existence, knowledge, values, mind and language. It's like having the curiosity of knowing of something with all questions, 'Why', 'How', 'If...and when I say philosophy of mathematics, you will be taken to history of how mathematics came to its existence. Again I am not going write long-long histories / some are short too don't worry [haha].

Basically, I want to say, you should have the love of wisdom and its fun, when you go through history and start seeing Mathematics with a different perspective, apart from today's day-to-day life, you might find something Worth your while. When someone is spending count-less hours, day and nights just to solve one problem and finally solving it, the feeling of joy is a crazy one, "Have you felt that joy?". Hopefully in your school days, getting a addition or multiplication or subtraction or division result correct. Hope you experience the same again. Math can be hard, but if you find tge right lens to look through, you will find that it's quite and exciting view albeit with numbers and symbols.

Now go, can't say which mystery is waiting for you but there surely is an advice-'never forget the basics'.

Prime Factorial: The Core of RSA Encryption

"Number theory is the Core of encryption"

Sofikul Islam
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Encryption, when this word comes in front of our eyes, the first line that strikes in our mind be like "Messages and calls are end-to-end encrypted". The first WhatsApp security protector line. Isn't it?

Security, this word makes us feel free from hesitation, decreases the burdens of minds and many more. This word security leads to the 'science of encryption'. i.e., CRYPTOLOGY.

Cryptology, the study of codes and ciphers. Wait! wait! no need to worry. We will understand these in a simple manner. It is the union of CRYPTOGRAPHY (Codemaking) and CRYPTANALYSIS (Codebreaking). Codes and ciphers are seemed to be same but not at all same to a cryptologist. Codes are prearranged substitutes for letters, words or phrases where a cipher are the algorithm to convert the messages into unreadable jumbles. Most cryptographic algorithm use keys, which are mathematical values that plug into the algorithms. If the algorithm lays to encipher a message by replacing each letter by a numerical equivalent (Say A = 1, B = 2 and so on) and multiply the result by some number x, then x represents the key to the algorithm. For example,if 5 is the key the word 'attack' turns into '5 100 100 5 15 55' with the key 6, it becomes '6 120 120 6 18 66'. Ciphers algorithms and ciphers keys are look like door lock & door keys. The lock made by the same company may works in a similar pattern but the keys are different for each and every lock.

We got a simple idea about encryptions. But the question that arises in onto mind is like, 'if it is very easy for a computer to decrypt the algorithm', then why we use this type of coding?

The question in our mind is absolutely right. Why? why do we use this? Now, to convert this "easy for computer" to "seem like impossible!". We will go through the mathematics which is most likely one directional function. For example, it is very simple to multiply numbers together, especially with computer. But it can be very difficult to factorize the number. Say, one asksus to multiply together 34537 and 99991, then it is simple for calculator to say 3453389167. But if one asksus to find that two numbers which is multiplied to get the result, then it is very much tough & time consuming. Isn't it?

RSA encryption (Rivest-Shamir-Adleman) is a public key crypto system widely used for secure data transmission. They described the algorithm in 1977 and called it "The algorithm of prime number".

They use the mod function as the key function. Say a message get the numeric value 'm', then

$$m^e \bmod(N) = C \text{---------(i)}$$

i.e., m multiplied e times to itself where 'e' is a public exponent, then divides it by a random number N. They call this remainder is the output (C), which is easy to perform. However, when C, N & e are given it is very tough to find m (same as the way we use trial and error method).So this is the one way functions that they took to apply as the mathematics lock.

To find 'm' we need other exponent say 'd' such that

$$C^d \bmod(N) = m \text{---------(ii)}$$

which undo the original message.

Therefore, from equation (i) & (ii), we get

$m(^{e^d})\ \bmod(N) = m$

i.e.,

$m^{ed}\ \bmod(N)=m$---------(*)

where, e is the encryption & d is the decryption. So we used a way to construct e and d in such a way which makes it difficult to anyone to find d using e. This required a second one way function to generate d.

STEP-I: For this they looked back to Euclid over 2000 years ago where he shows that any number can have exactly one prime factorization.So, whenever we multiply two hugely large prime numbers, it is impossible to find the primes using the result. Say take 'P_1' a prime of 150 + digits & 'P_2' of nearly same size. Then $N = P_1 . P_2$ is about of 300 digits.

STEP-II: We have to find a function which depends on factorization of N. For this we go to 1760, the Euler's ? function, which measures the break ability of a number, (N) is how many numberless than or equal to N that do not share any common factors with N and he gives the formula

$\phi(P) = P-1$ .... (iii)

$\phi(m.n) = \phi(m).\ \phi(m).$ ....(iv)

$(P^k) = P^k - P^{k-1}$ ....(v)

where P is prime. m . n are positive integers.

So, we have

$\phi(N) = \phi(P_1) . \phi(P_2)$

$\quad = (P_1 - 1)(P_2 - 1)$

Whenever factorization of N is known it is easy to find $\phi(N)$.

STEP-III : To connect $\phi(N)$ to mod function, we have from Euler's theorm-

$m^{\phi(N)}$ 1.mod (N)

we have to modify this to get m.mod(N), using simple mathematics, we get

(a) $1^k = 1$

$m^{k.\phi(N)} = 1^k.\bmod(N) = 1 \bmod(N).$

(b) $m.^{1k} = m$

$m.mk(N) = m.1.\bmod(N)$

$m^{k.\phi(N)+1} = m \bmod (N)$ ....(vi)

Again from (k)

$m^{ed} = m \bmod (N)$

i.e. $e.d = k.(N) + 1$

$$d = \frac{k.\phi(N)+1}{e}$$

Therefore it is easy to calculate d only if the factorization of N is known.

That is d is the private key.

Example :

Let m = 89. the message

(i) $p_1 = 53$ & $p_2 = 59$

(ii) $N = p_1.p_2 = 53 \times 59 = 3127$

(iii) $\phi(N) = \phi(p_1) . \phi(p_2)$

$\quad = (p_1 - 1)(p_2 - 1)$

$\quad = 52 \times 58$

$\quad = 3016$

(iv) Let e = 3, which does not share a factor with $\phi(N)$

(v) To find my privates code d.

$$d = \frac{2.\phi(N)+1}{3}$$

$$\frac{2 \times 3016+1}{3}$$

$= 2011$

Now I hide everything except N & e as they are public key. Now any public lock is message $m^e \bmod (N)$ that is $89^3 \bmod (3127) = 1394$, which he sends to me.

Now, I will use the private key d, $1394^d \bmod (N) = 1394^{2011} \bmod (3127) = 89$.

i.e., I get the original message m = 89.

So, d can only calculated when the prime factorization of N is known. For a unknown person, it will takes thousands of years ot decrypt it using the fastert computers.

Real life application of Differential Equations

Ankur Kalita
2nd Sem., Department of Mathematics

In 1925, Lotka and Volterra introduced the predator-prey equations a system of equations that models the population of two species one of which preys on the other. Let $x(t)$ represents the number of rabbits living in a region at time t and $y(t)$ the number of foxes in the same region. As time increases the number of rabbits increases at a rate proportional to the population and decreases at a rate proportional to the number of encounters between rabbits and foxes.

The foxes which compete for food increase in number at a rate proportional to the number of encounters with rabbits but decreases at a rate proportional to the number of foxes. The number of encounters between rabbits and foxes assumed to be proportional to the product of the two populations. These assumption leads to the autonomous system

$$\frac{dy}{dx} = (a - by)x \text{ - - - - - - - - } (i)$$

$$\frac{dy}{dx} = (-c + dx)y \text{ - - - - - - } (ii)$$

Where a, b, c, d are positive constants. The values of these constants vary according to the specific situation being modelled. We can study the nature of the population changes without setting these constants specific value.

Since population cannot be negative, therefore, we have $x(t) \geq 0, y(t) \geq 0$. First we determine where the rabbit and fox populations are both constants. Noting that, values remain unchanged when and . Then (i) and (ii) becomes

This pair of simultaneous equations has two solutions and . At these two points called equilibrium or rest points, both the populations remain at constant all over time. The point represents a place containing no member of fox nor rabbit species; the point corresponds to a place with unchanging number of both rabbit and fox species. By differentiating that function, we can show that and is a constant. While and change over time, doesnot. Thus is a conserved quantity and its existence gives a conservation law. A trajectory that begins at a point at time gives a value of that remains unchanged at future times. Each value of gives a

trajectory for the autonomous system and these trajectories close up, rather than spiralling inward or outward. The rabbit and fox populations oscillate through repeated cycles along a fixed trajectory. The below figure shows several trajectories for predator-prey system.

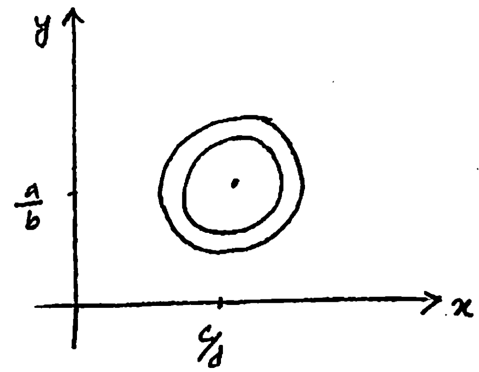

Figure - 1

In this way, we can analyse population of two species one which prey on other with the help of differential equation.

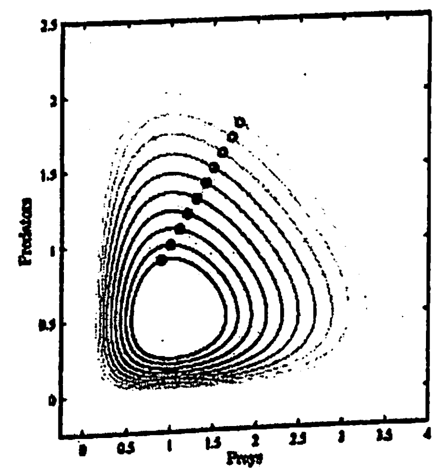

Figure - 2

Sum of Three Cubes

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In the mathematics of sums of powers, it is an open problem to characterize the numbers that can be expressed as a sum of three cubes of integers, allowing both positive and negative cubes in the sum. A necessary condition for 'n' to equal such a sum is that 'n' cannot equal 4 or 5 modulo 9, because the cubes modulo 9 are 0, 1, and -1, and no three of these numbers can sum to 4 or 5 modulo 9. It is unknown whether this necessary condition is sufficient.

Since 1955, and starting with the instigation of Mordell, many authors have implemented computational searches for these representations. Elsenhans & Jahnel (2009) used a method of Noam Elkies (2000) involving lattice reduction to search for all solutions to the Diophantine equation $x^3+y^3+z^3=n$ for positive 'n' at most 1000 and for max $(|x|,|y|,|z|)<10^{14}$, leaving only 33, 42, 74, 114, 165, 390, 579, 627, 633, 732, 795, 906, 921, and 975 as open problems for n less than equal 1000.

Now, Andrew Booker, a mathematician at the University of Bristol, has finally cracked it: He discovered that $(8,866,128,975,287,528)^3 + (-8,778,405,442,862,239)^3 + (-2,736,111,468,807,040)^3 = 33$.

In 2019, Booker, at the University of Bristol, and Sutherland, principal research scientist at MIT, were the first to find the answer to 42. The number has pop culture significance as the fictional answer to "the ultimate question of life, the universe, and everything," as Douglas Adams famously penned in his novel "The Hitchhiker's Guide to the Galaxy."

Over a million hours of computation later, the team had its solution. In the equation $x^3+y^3+z^3=n$, let $x=-80538738812075974$, $y=80435758145817515$, and $z=12602123297335631$. Plug it all in, and you get $(-80538738812075974)^3 + (80435758145817515)^3 + (12602123297335631)^3 = 42$. And with that, we've found solutions for all the values of n upto 100 (technically, up to 113).

Godel's Incompleteness Theorem

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In 1931, Mathematician Kurt Godel made a landmark discovery, as powerful as anything Albert Einstein developed. Godel's discovery not only applied to mathematics but literally all branches of science, logic and human knowledge. It has truly earth-shattering implications. Oddly, few people know anything about it.

In the early 1900's, however, a tremendous sense of optimism began to grow in mathematical circles. The most brilliant mathematicians in the world were convinced that they were rapidly closing in on a final synthesis. A unifying "Theory of Everything" that would finally nail down all the loose ends and mathematics would be complete. In 1931 this young Austrian mathematician, Kurt Godel, published a paper that once and for all proved that a single Theory of Everything is actually impossible. Godel's discovery was called" The Incompleteness Theorem".

Godel Consider the statement "I am lying". This is a self-contradictory statement, since if it's true, I am not a liar, and it's false; and if it's false; I am a liar, so it's true. This is known as "The Liar Paradox". Godel started his research with this statement and converted the Liar Paradox into a mathematical formula. He proved that any statement requires an external observer, no statement alone can completely prove itself true. From where Godel got the two incompleteness theorems.

The foundation of mathematics is the set of basic mathematical facts or axioms; that was both consistent, never leading to contradictions and complete. But Godel proved that any set of axioms we could posit as a possible foundation for mathematics will inevitably be incomplete. There will always be true facts about numbers that cannot be proved by those axioms. This is the Godel's First Incompleteness Theorem which states *"Any consistent formal system F within which a certain amount of elementary arithmetic can be carried out is incomplete i.e. there are statements of the languages of F which can neither be proved nor disproved in F."*

In mathematics we know that two parallel lines never intersect each other but if we say that the two parallel lines intersect at infinity then we get a contradiction. Actually we consider us in a closed system and predict that they intersect at infinity, but we cannot decide that our prediction is true or false. May be they intersect or may be not. To know the exact result we have to come out from the system i.e. beyond the infinity, which is not possible. This is the Godel's Second Incompleteness Theorem which states that *"For any consistent system F within which a certain amount of elementary arithmetic carried out, the consistency of F cannot be proved in F itself."*

Most interestingly, if we consider the whole universe is a closed system then from The Godel's incompleteness theorem we can say about the existence of God from the outside of the universe, which is not possible for us. Moreover Godel's theorem has been used to argue that a computer can never be as smart as human being because the extent of its knowledge is limited by a fixed set of axioms, whereas people can discover unexpected truths. It plays a part in modern linguistic theories, which emphasize the power of language to come up with new ways to express ideas. And it has been taken to imply that we will never entirely understand our self, since our mind like any other closed system, can only be sure of what it knows about itself by relying on what it knows about itself.

CHERN MEDAL

One of the newer prizes in mathematics is the chernmedal.Which began recognizing lifetime achievements for mathematicians in 2010, is awarded every four years.it is given out at the international congress of mathematicians and it includes a prize of $250,000.The first recipient in 2010 was Louis Nirenberg and the 2014 winner was Phillip Griffiths.

২নং হোষ্টেলৰ আড্ডা

অংকুৰ ৰাজ চেতিয়া
দ্বিতীয় ষাণ্মাসিক, গণিত বিভাগ

এখন এৰি অহা ডায়েৰী
দুখিলা পাত-এখিলা সম্পূৰ্ণ
আনখিলা আধৰুৱা।

হৃদয়ৰ ৰক্তাক্ত ক্ষত স্থানত
স্মৃতিৰ পাপৰি সৰিছে
পাৰ কৰি অহা সময়বোৰে
আজি মোক ৰিঙিয়াই মাতিছে,
কোনোদিনে নকৰা হিচাব এটা কৰিছো
কিমান সময় অপেক্ষা কৰিলে
আমাৰ আড্ডাৰ মাজৰ
কোলাহলত আকৌ এবাৰ নাচিম,
হৃদয়ৰ সমস্ত যন্ত্ৰণাৰে কবিতাতে
আজি আশ্ৰয়ৰ দিন সেই আধৰুৱা ডায়ৰীৰ
আধালিখা কথা,
হোষ্টেলৰ কেইটামানৰ গায়কৰ সুৰেৰে
আৱতৰীয়া বতৰতো যেন বিহু মঞ্চ
ক'ত আনন্দ আৰু খঙৰ ৰাতিবোৰ
য'ত বহি আমি শিকিছিলো
জীৱন কাক কয়।
এটা শেষ নোহোৱা গানৰ দৰে
দূৰ-দূৰণিলৈ আধৰুৱা সুৰ হৈ
বাজি থাকিব আমাৰ সকলোৰে
কম সময়ৰ মিলনৰ যাত্ৰাৰ
সুখ-দুখৰ অন্তত...

মুক্ত মোৰ আই

মিহিৰ কুমাৰ তালুকদাৰ
দ্বিতীয় ষাণ্মাসিক, গণিত বিভাগ

হয়, আজি মোৰ আয়ে প্ৰাণ খুলি হাঁহিছে
কাৰণ, আজি মোৰ আই মুক্ত।

উচুপি উচুপি ভাগৰি পৰা আয়ে, আজি উচুপা নাই,
কাৰণ, আজি মোৰ আই মুক্ত।।

আজি মুক্ত আকাশ-বতাহ, মুক্ত চৰাই-চিৰিকতি,
যৌৱনৰ আমেজ লোৱাত মত্ত প্ৰকৃতি।
প্ৰকৃতিয়ে আইক নতুন জীৱন দিলে,
হাঁহিব পাহৰা আইৰ মুখত পুনৰ হাঁহি বিৰিঙি উঠিলে।

বছৰ বছৰ ধৰি অৱহেলিত আই,
সন্তানৰ উচুপনিত আয়ে চকু পানী টুকিছিল
আজি আয়ে সন্তানৰ উচুপনিত চকু পানী টুকা নাই
কাৰণ, আজি মোৰ আই মুক্ত।

অ’ মই ভিক্ষাৰী

পাৰ্থ প্ৰতিম কলিতা
চতুৰ্থ ষাণ্মাসিক, গণিত বিভাগ

অ’ মই ভিক্ষাৰী
ৰাস্তাৰ কাষত কিবা এমুঠি খুজি মাগি খাওঁ
সেয়ে মই ভিক্ষাৰী।

আৰু তহঁত
নিজৰ সকলো বস্তুৰ বাবে যে
বেলেগৰ ওচৰত হাত পাতি থাক
প্ৰাপ্য বুলি কৈ ৰেচনৰ পৰা কৰ্মলৈকে

বিচাৰি বিচাৰি তহঁতে ঘূৰি ফুৰ...
আমাৰ কি সেইবোৰ প্ৰাপ্য নাছিল

কিন্তু আমি ভিক্ষাৰী
সুধিছ জানো কেতিয়াবা কিহৰ তাড়ণাত
আজি আমি ভিক্ষাৰী
আচলতে আমি সকলোৰে ভিক্ষাৰী
হাঁহি উঠে কেতিয়াবা অ’

যেতিয়া আমাক ভিক্ষাৰী বুলি ইতিকিং কৰি
নিজেই ৰাতি কাৰোবাৰ ওচৰত প্ৰেমৰ ভিক্ষা খোজ।
সেয়াটো তহঁতৰ ভিক্ষা নহয় সেয়া তহঁতৰ প্ৰাপ্য
কিন্তু আমাৰ
আমাৰ প্ৰাপ্য বুলি একো নাই সকলো ভিক্ষা
সেয়ে মই ভিক্ষাৰী।

মল্লিকা

দীপশিখা হালৈ
চতুৰ্থ ষাণ্মাসিক, গণিত বিভাগ

কোঠালিটো আন্ধাৰ
মৌনতাই কোঠাটোৰ কোণত বাঁহৰ পাতিছেহি
কাষলৈ গৈ চালো, সেয়া মোৰেই এটি ৰূপ
নহয়নে হাতত হৃদয়ৰ এটি টুকুৰা লৈ
মনে মনে বহিছে তাই নীৰৱে
এছাতি বতাহে চকুৰ পৰা চুলিখিনি উৰুৱাই নিলে
কিন্তু এইজনীটো মই নহয়
মইটো চকুপানী নুটুকো
মইটো নাকান্দো আন্ধাৰৰ সুযোগ লৈ
—‘হেৰা কিনো হ’ল তোমাৰ?’
—‘একো নাই। এই টুকুৰাটো দেখিছা নে?’
—‘উম’
‘নোৱাৰিলে অ’ কঠোৰ শব্দবোৰ, বেদনাবোৰ,
মনত বান্ধি ৰখা কথাবোৰ লৈ ফুৰিব’
তাৰ পিছত?
জিৰাইছেহি মোৰ কোলাত
কিন্তু তুমি যে কান্দিছা?’
তুমিটো দিনৰ মল্লিকা, আমিহে ৰাতিৰ দাসী।

धुँधले सड़को पे

हिरक ज्योति शर्मा
चतुर्थ षण्मासिक, गणित विभाग

अक्सर चल पड़ते हैं
धुँधले सड़को पे
खुद की मंजिल धुंडने
हम आगे बढ़ चलते हैं।
न मंजिल का कोई पता हैं
नहीं शुरूवात की यादें,
हम तो बस राही हैं
ले चला दुनिया जहां
वही अपनी कामयाबी तलाशते
बस निकल पड़ते हैं।
रोज कुछ कदम आगे-पीछे कर
यूंही चल लिया करते हैं
धुँधली राहों पर चलते चलते,
थोड़ा जी लिया करते हैं।

ফাগুন

চাহিদুল ইছলাম

চুৰ্ণি খহাই
তোমাৰ বুকুৰে নামি যায় ফাগুন

চহৰত ফাগুন
বুকুতো মোৰ

উঠি অহা সুৰ এটাৰ
আঁচলত ধৰি আগবাঢ়িলো
নীলাচলৰ নামনিলৈ

প্ৰেমৰ পাহাৰ
শিমলু পথাৰ

বহুদিন ব্যাথা বঢ়ালো
অলপ প্ৰেমকে পান কৰোঁ

লাজত ৰঙা চহৰখনক
শিমলুৰ বুকুত গুজি দি
হেৰাই থাকোঁ
তোমাৰ বুকুত।

Students of our Department who secured 1st Class in B. Sc. Final Examination (Batch 2016-19)

- AmarJyoti Nath
- Ankur Upadhyay
- Angshuman Sarma
- Bharat Ch. Saikia
- Bijit Das
- Bedaprat Das
- Chinmay Saikia
- Dheeraj Boral
- Gaurav Bardhan
- Gaurav Kalita
- Hrishikesh Parashar
- Hafizur Rahman
- Jyotishman Bhagwati
- Ratul Choudhury
- Susil Sarma
- Sudip Dey
- Utpal Das
- Upamanyu Deka
- Anusuya Roy
- Gargi Gayan
- Habibur Nehar
- Indunesi Saikia
- Monica Dev
- Puja Chetry

Total 1st Class = 24 (out of 32 appeared)

Students of our Department who secured 1st Class in B. Sc. Final Examination (Batch 2017-20)

- Amit Thakur
- Bijoy Dahal
- Dhrutismita Das
- Gyandeep Baruah
- Himangshi Deka
- Manali Paul
- Md Ali Abbas
- Nilimjyoti Sarma
- Nipankar Kalita
- Paushali Nag
- Rashel Gogoi
- Rimjyoti Baishya
- Raktima Medhi
- Sewabrat Dutta
- Shabari Das
- Shuvam Das
- Washminara Begum

Total 1st Class = 17 (out of 29 appeared)

DEPARTMENT ACTIVITIES

Department Annual Lecture, 2020

Wall Magazine, 2020

Teacher's Day Celebration

Department Picnic


6th Semester


4th Semester


2nd Semester