infinity

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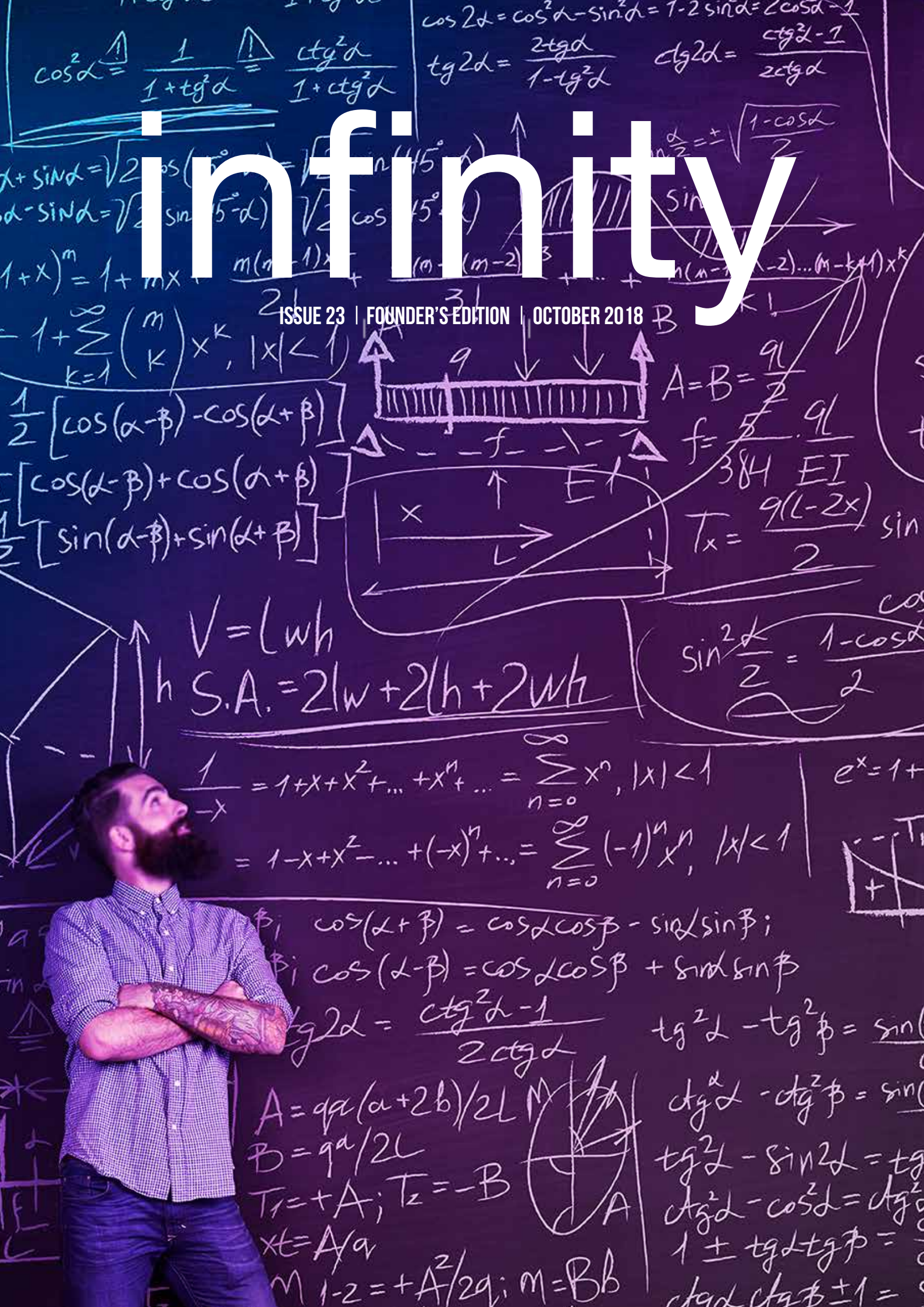

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PURE MATHEMATICS IS, IN ITS OWN WAY, THE POETRY OF LOGICAL IDEAS.

-ALBERT EINSTEIN

Cover Designed by Raghav Saboo

EDITORIAL

Four years.
Eight issues.
Infinite memories.

As my time with the Infinity is coming to an end, I am nothing but thankful for all that this publication has taught me. I would be lying if I said that writing my last editorial did not feel overwhelming, to say the least.
My journey with this publication is one I truly cherish and celebrate. I remember the young B-Former trying out for the editorial board of the Infinity and explaining to Shrey Aryan his love and passion for the subject of mathematics. I remember the A-Former who spent almost every night toye in Tejit Pabari's study for a whole term to work for a publication he immensely loved. I remember the S-Former constantly debating and discussing with Chaitanya Gulati, about how he thought we should proceed with the publication for the year. Interestingly, I now see young juniors, like Anant, trying out for the board and explaining to me their passion for the subject. Now, A-Formers like Keshav, Vardhan and Sudhir spend their evenings working on the publication. Now, S-Formers like Vansh, Aneesh, Arjun and Harsh debate and discuss with me how they think we should proceed with the publication. Everything seems to have come full circle.

The beauty of this is not only that I get to experience what my Editors-in-Chief got to experience in their time, but also that I can see a similar sense of love and passion for the publication and the subject as I have had in the past four years. This gives me a sense of joy and pride and makes me extremely confident that the Infinity is in good hands for the coming few years. I have learnt a lot from my Editors-in-Chief, but along with them, I have also learnt so much from my juniors. As I see the S-Formers slowly taking charge and bringing so much to the table, I cannot help but already feel excited for their founders' issue, which will happen to be the 25th issue of the magazine. I have seen them since their B-Form and they have continued to surprise me with each issue. They are truly one of the most talented batch the Infinity has seen in the past few years.

This term's issue of the Infinity has the regular section Crème de la Crème, where we will share with you the life of the mathematician, George Boole. Also, in Mathematics in Popular Culture, we have the reviews of the book, How Not to be Wrong by Jordan Ellenberg and the Spanish thriller film, Fermat's Room. Our special section this term, titled World Tour, will take you on a trip around the globe, showing you what contribution has each of the seven continents made to the world of mathematics. Earlier this term, one of our ex-HOD of Mathematics, Dr. Mona Khanna left Chandbagh. We also have an interview of hers, where she talks about life in school, the evolution of mathematical teaching and more. As always, we have some some interesting problems for you to try your hands on and a checklist of some books and movies you may enjoy. We also pay homage to a few brilliant mathematicians, who passed away earlier this year in our section The Legend Lives On. With all this and more, it has been our endeavour to make the following pages both entertaining and educative in nature.

Happy reading!
Signing off,

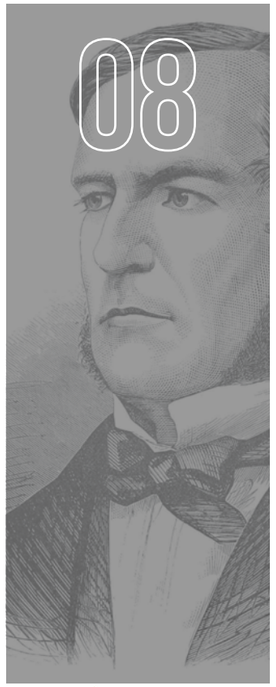
Abhiraj Lamba
Editor-In-Chief

what´s inside

FEATURED ARTICLES

AULD LANG SYNE

The Infinity interviewed Dr. Mona Khanna

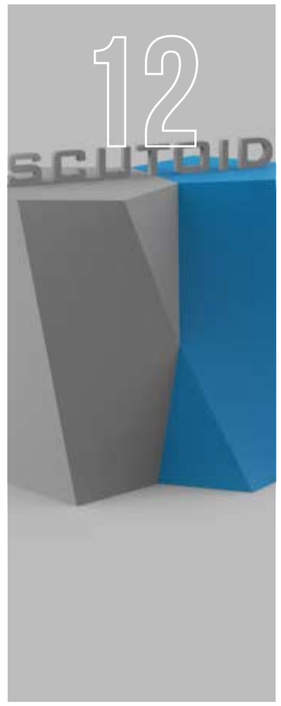


CRÈME DE LA CRÈME

A timeline highlighting the struggles and achievements of Geogre Boole.

BEATING THE CLOCK

A report on the International Math Competition conducted in Amsterdam this year.



SHE $CELLS SHAPES

Keshav Raj Singhal talks about the discovery of a new shape.

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Fermat´s Room

A brief review of the popular spanish movie.

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Problems to Ponder Upon

5 mathematical question that will leave you perplexed.

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Mathematical Indika

A report on the mathematics camp recently held in Mumbai.

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Mathematician´s Checklist

Handpicked entertaintment to cherish this Founder's Break!

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> No matter how correct a mathematical theorem may appear to be, one ought never to be satisfied that there was not something imperfect about it until it also gives the impression of being beautiful.
>
> -George Boole

GOOG{O}L

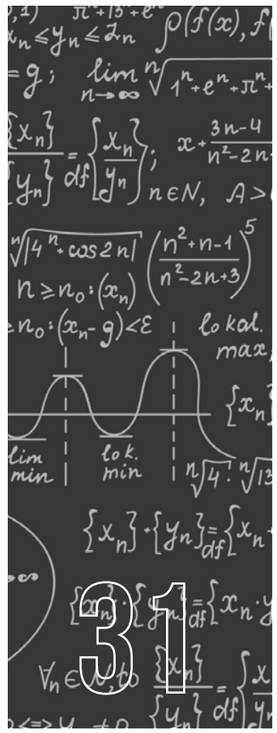
Shreyas Minocha writes about the Mathematics involved in computer science.

WORLD TOUR

Join us as we take you around the world in 8 spreads.

CHALLENGE YOURSELF

A few puzzles to exercise your neurons.



THE LEGEND LIVES ON

The Infinity pays tribute to four mathematicians that passed away this year.

DR. MONA KHANNA

Auld Lang Syne

Infinity bids farewell to our beloved master in the form of an interview. Dr. Mona Khanna has been appointed the vice-principal of Unison World School and we wish her the very best on behalf of the school community.

FAREWELL

Since the time you joined Chandbagh, how do you think Math as a subject has evolved? What changes do you think have taken place in the methods of teaching and learning Mathematics at Chandbagh?

When I first joined school in 2007, they had just introduced the I.B and I had been an I.B teacher for a year and a half before coming here. The approach here was not very traditional, in the sense that it was a boarding school. Due to the teachers being well trained and experienced, the teaching method was very unique. We do not emphasise on learning more formulae, because at a particular stage the curriculum also does not require it. It is the whys and hows that are more important. Learning this way is much more interactive and engaging than the traditional style. Even the competitive tests- PRMO, Waterloo, Fermat, etc- were never there earlier. The Founder's Day exhibition and the Infinity quiz are also great examples of how mathematics in school has evolved over the years. It was the headmaster's first year in school, and he was genuinely surprised, when he saw that the math exhibition was not the usual one. Origami and cards were introduced to convey the concept of probability in a more comprehensive manner. The Escape Room puzzle is another example of how complex topics were portrayed using practical examples rather than traditional teaching methods.

What advice would you give to the students in the school?

Doon is a great place to explore new dimensions. However, Doscos must hone skills that they are adept at. My advice for junior batches is that they should walk around and grab all opportunities that they are provided with. They should not have any fear of people judging them. They must strive towards excellence and not worry about the outcomes. On the other hand, I would encourage the senior batches to look beyond these four walls. They must not have the notion that they are Doscos and thus, know everything. There is a huge world outside and they are competing with people who are as capable or even better than them. When they are applying to colleges, they must realise that there are people who are as skilled or hard-working as them. They must put in their best so as to make a difference in today's world.

How do you feel the student-teacher relationship has changed in school over the years?

I joined school on the 2nd of May- the same day as a new D form batch joined. I was their tutor, and we used to stay outside, completely lost in our surroundings and new to the Dosco terminology. We discovered this place together, we learnt together, and this made our student-master relationship deeper. I am family to a lot of them. I cannot remember

"The connect - that is my strength."

a single Teacher's day or Thanksgiving day, when they did not wish me. As soon as they enter the school, the first thing that they find out is where I am. This is the type of student-teacher relationship that I think is missing nowadays, and it is not just the students but the masters too who sometimes do not engage in such relationships. I think they should become more embedded in the system; they should become a boarding school master, and only then will they find that they are a part of this extended family. Boys should also spend more time away from their gadgets and with the masters. Earlier, they used to walk into the masters' homes and this is how the relationship between them flourished.

You have been teaching for many years and have trained many students in problem solving. How would you personally approach any problem and why would you choose such an approach?

From a very early age, I have had to face a lot of problems, and unfortunately, I often had to face them alone. So personally, I would prefer a head-on approach. Also, I would advise everyone to always look at the most pertinent problem at hand, and set aside any other problems which can be tackled later. In this, way, most of the obstacles in life can be successfully overcome.Whenever I approach a mathematical problem, the first step for me is to connect it to one of the broader areas or disciplines of mathematics. Only then do I narrow down on a particular problem-solving technique. Sometimes, I also work backwards from the solution of the problem, and explore its possible implications. However, after this or after arriving at the solution using 'Hit and Trial', I always go through the theory, and try to understand how the problem could be solved following the traditional approach. Also, if I am not able to solve a particular problem, I always put it on my task list, so that I can read about the problem and its associated topic later.

What is it about teaching that keeps you motivated to continue teaching the same thing over and over again?

I am a teacher at heart even though I am leaving for an administrative position. I chose to be a teacher; I did not join the profession due to some compulsion. I am a PhD; I could have been a lecturer in some college too, but I chose to be a teacher. Also, the classes were different each year. I had different sets of students every time, which made each class experience unique. Different sets of students come up with different questions on the same topic. Sometimes I change the approach to a particular topic depending upon the class and the classroom environment. All of this gives me a huge amount of excitement.
The new classrooms with the whiteboards at the back and the desks on which students can do their work also make the classes much more enjoyable and interactive. Moreover, with Aneesh in the class, I have learnt so much - I think that is one of the best examples of how much we learn and hence, wish to keep going.

What would you like the students to remember you the most by?

The connect - that is my strength.

What will you remember the students the most by?

The connect, it is vice-versa. I will miss every little thing about this place and it's not just the masters or the boys but also the campus that I will miss.

CRÈME DE LA CRÈME

GEORGE BOOLE

George Boole is recognised for the creation of the concept of boolean

November 2nd 1815

Born to a shoemaker in Lincolnshire.

Early 1830

Got little formal education as his father became broke. Started to teach himself.

1831

Became a teacher at Heighams School, Doncaster.

1834

After years of struggling, he opened his own school in Lincolnshire.

1838

Started publishing research papers and got an offer from the University of Cambridge but he refused when he realised that it would result in him discontinuing his research.

1849

Became professor of mathematics at Queens College, Cork

Early 1855

Got married to Mary Everest.

Late 1855

Awarded the Keith medal by the Royal Society of Edinburgh for his contribution to the theory of linear differential equations.

1858

Developed the concept of boolean algebra which relates to the algebra of binary numbers and forms a fundamental concept in logic gates and computer science.

December 8th 1864

Died of pneumonia.

Salas, Jasmine. "Boole - 19th Century Mathematics - The Story of Mathematics." The Story of Mathematics, 12 May 2016, www.storyofmathematics.com/19th_boole.html.

FERMAT'S ROOM

By Arjun Agarwal

Imagine being trapped in a room with no exit and the only way out is the answer to a riddle that you have to solve in under a minute. Pretty commonplace, isn't it? But the exciting fact is that the room would start shrinking if you are unable to solve the riddle, leaving you with your mind as the only tool to get out. Well, that is what Fermat's room is. A brilliantly made Spanish movie , 'Fermat's room' intrigues the watcher right from the start when an anonymous invitation is sent to four mathematicians inviting them to a convention, under the alias of a mathematician assigned to them. The movie turns into a thriller when they are trapped in a room, and are trying to decipher who the host could be. Directed by Luis Piedrahita and Rodrigo Sophena, this movie takes maths to another level of simplicity and elegance. It captures the true essence of math, i.e., logic.

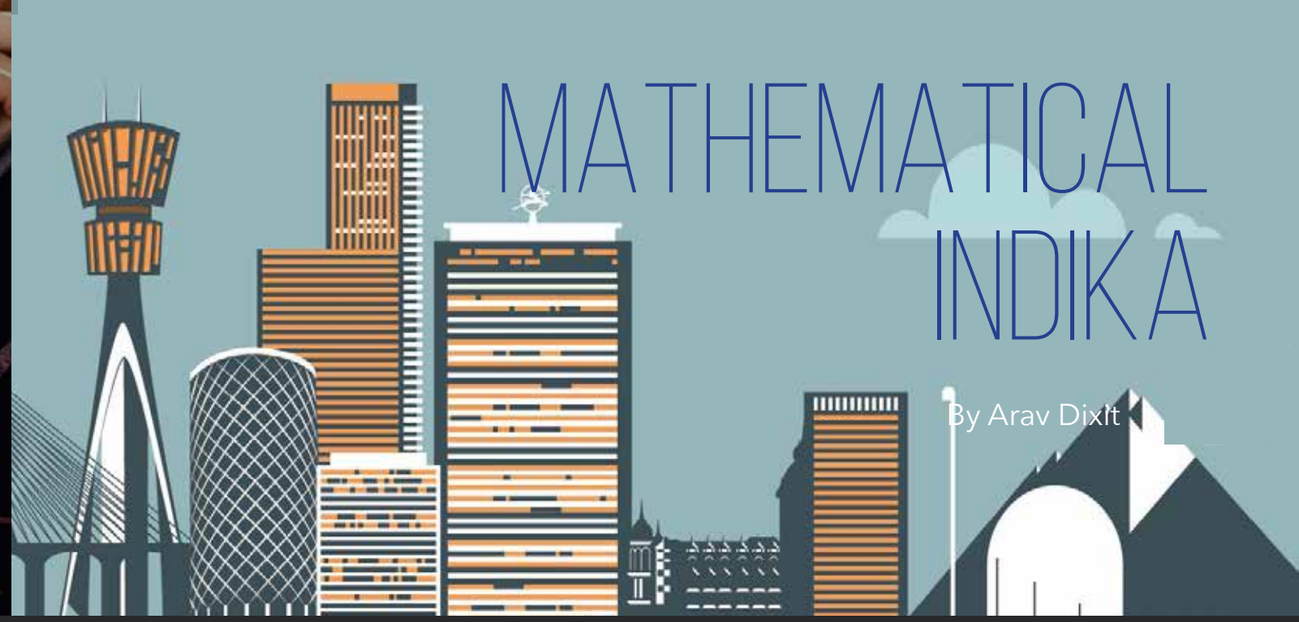
Themes such as that of love, betrayal, revenge, ethics constantly feature throughout the movie. It shows how beautiful and complex the world of mathematicians can be. Alejo Saurus as Galileo constantly creates suspense and an atmosphere of doubt throughout the movie. The use of 'intertexuality', the ability to refer to another text or movie, is brilliant.

Through this tool, the director tries to connect with the audience, for all mathematicians have heard of the Goldbach's Conjecture and the proof of it. There are also references to the lives of the mathematicians featured in the movie, which really makes it very interesting to watch. The way the end of the movie is connected to its beginning like a circle is also mind-blowing.

"Imagine being trapped in a room with no exit and the only way out is the answer to a riddle"

Parallels can be drawn between this movie and Agastha Chistie's book, 'And Then There Were None.' Written in the same theme and same idea, these two convey the same idea, that of guilt and ethics, through different media of communication. The setting of the room in the movie is also very significant to the theme conveyed as it evokes a kind of puppeteer in the mind of the watcher that is controlling the entire show. In all, 'Fermat's room' is a must-watch for all those interested in mystery, and maths. It is brilliant not just because of a brilliant plot or brilliant acting but it is the direction and the atmosphere created that makes 'Fermat's Room' this good.

"Parallels can be drawn between this movie and Agastha Chistie's book, 'And Then There Were None.'"



MATHEMATICAL INDIKA

By Arav Dixit

I was at home when I got to know about this foundation placed in Mumbai called 'Raising a Mathematician Foundation'. Its aim is to find talented students in the field of Mathematics and motivate them to make a career in Mathematics. It was a seven day national level residential camp in Mumbai for students of age 13-15. The selection for the camp is merit-based. After few days, they sent the selected candidates a work set which had to be completed and submitted to them at the starting of the camp. The work set was based on something which most of us might have never heard about. It was Varga Prakriti or incorrectly called Pell's Equation. Pell's equation is a Diophantine equation of the form

$$x^2 - Dy^2 = 1$$

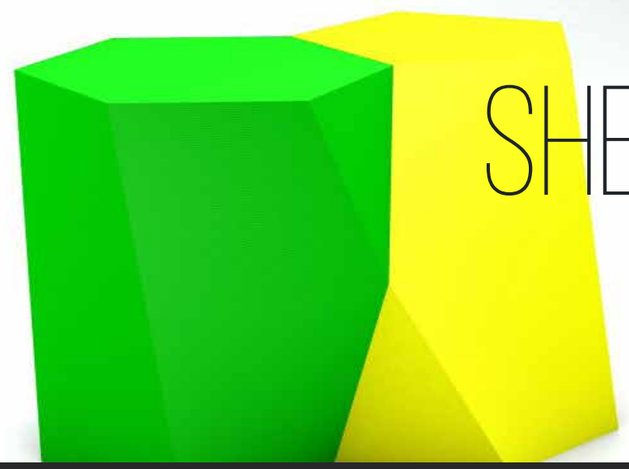
where x,y $\in \mathbb{Z}$ and D is a non-square natural number. An equation of the form $x^2 - Dy^2 =$ a for an integer 'a' is usually referred to as a Pell-type equation. There were quite a few methods to solve Pell's equation like Chakravala and Brahmagupta's Lemma. The question paper consisted of only six question, but solving them was like bringing heavens to earth, the task was next to impossible. This was primarily because I had never been exposed to such type of questions and theorems.

The camp was held from 20th to 26th of May, 2018 in Ram Ratna Vidya Mandir, Mumbai. The first day was an introductory session where we were told more about the camp and divided into groups based on difficulty levels. The groups were named after the great Mathematicians: Brahmagupta, Ramanujan and Manjul Bhargava.

The highlight of the camp were the talks given by Professor Shyam Willupuri on geometry and artificial intelligence. There was tremendous learning in those talks, and I personally never imagined that theorems that he told us about could exist in math. Apart from that, we studied topics ranging from Game Theory, Geometry, Theory Construction, , Combinatorics to topics such as Cyclic Quadrilaterals, Proof by Induction or Contradiction, Series, Chakravala, Boolean Algebra, and others. One interesting method we learnt was the Kuttaka method, which is an ancient method used to solve indeterminate equations of the form ax - by = c.

"The camp was an amazing experience"

We even had meditation of 20 minutes every morning. This refreshed and prepared us for the continuous Math classes that took place from morning till evening. At night, we there was a doubt clearing session with all the teachers. In all, the camp was an amazing experiences that taught me such complicated topics in such simple ways that I will remember them for life.



SHE SCELLS SHAPES

By Keshav Singhal

Every scientist has a dream of discovering or inventing something that has never been revealed to the world before. With time comes change and innovation, but this era has left many to question whether technology is the only sector that has a scope of massive growth. The human ideology has indeed evolved and has started to pour more and more resources into research in biotechnology and computers. It seems almost impossible to conceive that even after thousands of inventions in the past, mathematicians and scientists have not failed to impress the world with new discoveries. Interestingly, 'Scutoid', an unnamed shape a month ago, has been discovered by scientists while studying the human body's cell structure!

Verbally describing this structure would do not do justice to the peculiarity of this shape. But in very basic terms, with five sides on one end and six sides on the other and a triangle at its longer edge, scientists have tried to call it something like a 'twisted prism'. This structure essentially allows tissues to form around organs easily.

The result of the US-EU led collaboration in the research of tissues and organs has baffled many. But as a matter of fact, this structure forms one of the four forms of tissues in our body which make up organs, ultimately forming the human body! In scientific terms, this shape is formed as a result of the formation of a tissue by a number of epithelial cells. When these cells join together, they form a sort of prism or take the shape of a column. The most important part of the formation of Scutoid lies in the deformation of tissues. As tissues deform, one end of the edge grows wider which further gives room for the expansion of the outer surface more than the inner surface. That is what gives rise to the complete formation of the scutoid.

Countless analogies have been made to other existing structures in order to confirm the discovery of this one. One such example is the 'frusta', like in the Roman arch. However, all comparisons have failed.

The discovery of this structure has also given rise to further research in the biological industries. Scientists haven't restricted their theory to the human body but have gone on to pursue the existence of this shape in nature and the results have been commendable.

Considering that this structure has been discovered during the development of tissues, scientists sought keen interest in finding more proof for its existence. Thus, they observed the developing embryos of flies. As these embryos got divided, the scientists noted that the cells curved and folded to form salivary glands whose basic structures also took a scutoidal shape.

One of the stimulating properties of this shape is that it saves the energy of the human body. Not only do cells require energy in order to combine with each other but they also need it to maintain their bond. This structure minimises the energy requirements and helps in folding and overlapping over other cells, hence forming a tight grip.

It is indeed fascinating to note that a structure that primarily develops into one of the main tissues of our body had not been discovered before. This does not intend to discourage the scientists on their recent feat but, it throws light on the countless amazing things that are yet to be discovered. As a result of its development into tissues, one can also claim that it is all over you!

"One of the stimulating properties...it saves the the energy of the human body"

Saplakoglu, Yasemin. "Geometry Has a New Shape. Meet the 'Scutoid.'." LiveScience, Purch, 30 July 2018, www.livescience.com/63207-scutoid-new-shape-nature.html.

GOOG{O}LE

By Shreyas Minocha

Computer Science at its core is a highly theoretical field. Like many other fields, it borrows a lot from mathematics. From the earliest stages of the evolution of computers to the latest breakthroughs, mathematics is present throughout CS.

At the bottom most level, computers work through logic gates. The binary number system is commonly associated with computers. This is because at the chip-level, computers can distinguish only between a high voltage (1) and a low voltage (zero). The very basic logic gates, AND, NOT, OR, etc. combine to form larger components such as the Arithmetic and Logical Unit (ALU). The branch of mathematics that determines how combinations of these gates work is called boolean algebra.

An algorithm is a set of rules or procedures which are followed to solve a problem. The algorithms sub-field of computer science has a large scope for research. To efficiently solve problems, efficient algorithms are necessary. One of the chief ways mathematics is involved in algorithms is measuring their efficiency. In mathematics, coming up with a hypothesis is only half the battle. Writing a proof establishes its legitimacy. Similarly, a large part of publishing an algorithm is proving its efficiency. Computer Science borrows mathematics' concept of the Big-O notation. This notation allows us to place an upper-bound on the amount of time or memory an algorithm will occupy in relation to the size of the input. For example, Bubble Sort, a sorting algorithm, is said to run in (n^2). This means that as we vary the number of elements that are to be sorted, the time the algorithm take increases approximately quadratically. The concept of Big-O notation is powerful since it allows us to ignore terms of lower order which have little significance on the overall time/memory taken. If an algorithm creates a constant number of variables that doesn't change with the size of the problem, its impact on the overall memory taken by the algorithm is negligible.

"CS, like several other fields, is built over a mathematical foundation."

Mathematics is usually involved in other parts of the proving process as well. For example, the analysis of Merge Sort's run time uses recurrences and base 2 logarithms to prove that the technique takes linearithmic $n \log_2 n$ time.

Another concept of mathematics that pops up in theoretical computer science is graph theory. Graph theory has several real world applications such as networking, aircraft scheduling, recommendation systems, etc. To translate solutions in theory to solutions in practice, implementing graph theoretical solutions in the form of algorithms is essential.

Machine learning (ML) is a subfield that is rapidly gaining popularity these days. ML involves trying to come up with a model to explain a given large set of data. Naturally, a large chunk of ML is mathematics. Linear algebra is a branch of math that plays a major role in ML. In particular, concepts of decomposition, matrices, projections and vectors come up all the time. Probability and statistics are also essential to this field. Combinatorics, Bayes' Theorem and standard distributions are among some of the statistical topics that are critical to ML. Apart from these, multivariate calculus, real and complex analysis, the Fourier transform and information theory play a major role in ML.

These are just some commonplace examples of mathematics in CS. This goes to show that CS, like several other fields, is built over a deep-rooted mathematical foundation.

Akinfaderin, Wale. "The Mathematics of Machine Learning – Towards Data Science." Towards Data Science, Esha Dhawan, 24 Mar. 2017, towardsdatascience.com/the-mathematics-of-machine-learning-894f046c568.

BEATING THE CLOCK

Kabir Subhaiah reports on the recently concluded mathematics competiton in Amsterdam

During May 3 rd to May 9 th , a band of six boys - Agam Bhatia, Tushar Jalan, Gobind Bhatti, Arnav Chaudhry, Advay Sapra and Kabir Subbiah, escorted by ANC Sir, participated in an International Mathematics Competition. Widely known as ISMTF, the event was hosted by the International School of Amsterdam and gave the Doscos the chance to experience things we never knew even existed.

We arrived in Amsterdam bright and early on May 4. After dropping the luggage at the hotel and freshening up, we rushed to Alkmaar, a cheese village. Although we missed the main draw - a cheese auction, we were able to catch some of the action, and buy their fair share of the unorthodox cheese. European desserts evidently impressed the team as tell-tale traces of chocolate and whipped cream could be found on everyone's lips (and shirts). After a delectable lunch and some sightseeing, we returned to their hotel in time for registration and a welcome dinner. We were amazed at the efficiency and punctuality of the Dutch public transport system.

The following day was the competition, and all of them were quite excited. Being quintessential

"Doscos headed to the renowned Rijksmuseum – which was full of memorable treasures like Rembrandt's Night Watch."

Doscos however, we could not help but be distracted by the fabulous food the host school served – fresh bread, cheese, bacon, hot chocolate and more! After a fantastic meal at the cafeteria, we headed for the ten-round written competition with bated breath. We represented two of the 70 participating teams from various International schools, mostly from Europe yet most having at least one Indian or Chinese student! Agam, Tushar, and Kabir were in one team and Aarnav, Advay, and Gobind in the other. Tension was palpable as we all waited to turn over the question paper for Round 1. We started as

"The joy that remained with them throughout the trip – during the competition, sightseeing, meals and even arguments, was ubiquitous."

soon as we could, not wanting to miss a precious second of the time allotted. After five tedious rounds, we went downstairs for a break and explored the library.

Replenished, the team breezed through the next five rounds, making a few mistakes. Whilst the results were being processed, we received a superb talk from the Math faculty. Cloaked as a murder mystery, the session taught us about the discoveries of some great mathematicians including Ramanujan and Euclid. The afternoon offered breakout sessions like Sudoku, Rubiks Cube, math puzzles & games, and a Pi Digit competition the aim of which was to recite maximum digits of Pi.

Kabir was able to manage a meagre thirty-five digits, while the winner reached seven hundred and fifty nine effortlessly! We were even more astounded to know that Agam, Tushar and Kabir had placed ninth! That Math could be so fun was somewhat of a revelation to us all. We rewarded ourselves with ambrosial Italian dinner and Dutch dessert, and followed it with an enjoyable 5-kilometre walk back to the hotel. What a day it had been!

A unique event had been planned for the next day. The Sunday Chase saw twenty-five randomized, mixed teams following a map, and solving twelve math problems hidden all over the square, Museumplein. Tushar's team came fourth, Advay's third and Agam's first. A picnic lunch later, the Doscos headed to the renowned Rijksmuseum – which was full of memorable treasures like Rembrandt's Night Watch. We then headed off to the Keukenhof gardens, laden with exquisite tulips

"Whilst the results were being processed, they received a superb talk from the Math faculty. "

in every colour imaginable, presented artfully. The flowers and the traditional wooden windmills made for spectacular pictures. Monday saw us rushing to Amsterdam for a bike ride, followed by the Van Gogh Museum. We headed to the airport, but not before tasting delicious Dutch waffles! Arnav's hand in a cast led to an interesting situation at immigration. The return journey was uneventful; ANC Sir and Tushar bet on who could score a stick-cricket century faster. The stakes were an exemption of schools, but one of the contenders was snoring by the time the other hit 102.

WORLD TOUR

In this special section we take you on a trip around the world, and present to you the best.

ANTARCTICA

Robert Jacobel

The applied mathematician has studied fluid dynamics,solidification/meltingandmushylayer formation in aqueous systems, his works are very apt for a continent such as Antarctica. He has been associated to various publications such as the Journal of Glaciology and The Cryosphere.

Ken Golden

The 56 years old adventurer has been conducting research in Antarctica for a long time. This man is seen as a perfect mix of adventure and math by most. Golden has used a broad array of mathematical techniques to study sea ice and many other composites, including lattice and continuum percolation theory, and homogenization for elliptic and parabolic partial differential equations.

Nuguid, Anne. "Maths Takes You Places... Glaciologist in Antarctica - AMSI." History and Applications - Kinematics before Newton, AMSI, 27 Oct. 2016, amsi.org.au/publications/glaciologist-in-antarctica

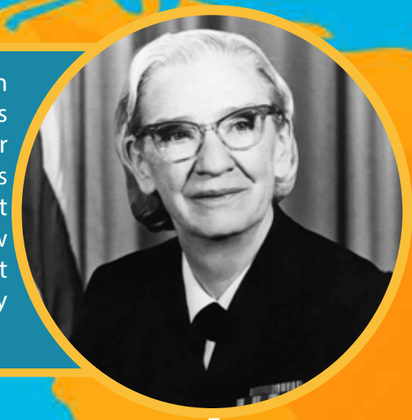
NORTH AMERICA

Benjamin Banneker

The mathematician applied maths into most of his work in the form of astronomical research. He was inspired by an industrialist, Joseph Ellicott, and started astronomical calculations in 1773. His calculations gave the positions of the planets and stars for each day of the year, and his almanacs were published annually from 1792 until 1797.

Grace Hopper

The mathematician, like most of the mathematicians from her country, didn't confine her application of mathematics to conventional maths but applied it in the field of computer sciences. In 1969, she won the award for"Computer Sciences Woman of the Year" by Data Processing Management Association. By 1973, she was made a Distinguished Fellow of the British Computer Society, which made her the first woman from the United States of America or any nationality to become part of it.



Edward Witten

The American mathematician uses math mostly in theoretical physics. Witten carries out research in theory of quantum gravity, super symmetric quantum field theories, superstring theory and other areas in affiliation with mathematical physics. Time Magazine in 2004 proclaimed that Witten was tne of the world's greatest theoretical physicists. He is also known for coming up with a natural solution to the hierarchy problem in physics.

Edward Lorenz

The mathematician was a professor at MIT and also a meteorologist. The mathematician questioned the applicability of 'linear statistical models' in the field of weather forecasting because most 'atmospheric phenomena' are non-linear. His research on this topic, titled 'Deterministic Nonperiodic Flow' was published in the Journal of Atmospheric Science, which the led to the chaos theory. His contributions are considered extremely valuable to modern mathematics.

Pacy Mathew. "Mathematicians from the United States." Ranker, 21 Apr. 2015, www.ranker.com/list/famous-mathematicians-from-united-states-of-america/reference.

SOUTH AMERICA

Elon Lages Lima

The Brazilian mathematician's research concerned differential topology, algebraic topology and differential geometry. Lima was an influential figure in the development of mathematics in Brazil. He has written over thirty books in mathematics, some of which were intended for secondary school teachers. Between 1990 and 1995, he coordinated the IMPA-VITAE project which held skills improvement courses for mathematics teachers in Brazil. He is nationally respected in Brazil for his work.

Tatiana Toro

The 54 years old mathematician's research is at the interface of geometric measure theory, harmonic analysis and partial differential equations. She has also made significant contributions to the potential theory and the free boundary theory.

Julio Garavito

The Colombian mathematician and astronomer vastly contributed to the development of sciences and mathematics in Colombia. He presented a thesis that consisted of calculating all the mathematical possibilities that a manometer has. To qualify for the title of Civil Engineer, he developed a type of triangularstructure to build bridges. Furthermore, he served as the director of the astronomical observatory. In his honor,one of the lunar craters visible from Earth was named after him in 1970.

Carlos Albán

This mathematician was primarily an inventor and is known for his application of maths and sciences. He is credited for the design of the 'powerful telescope'. He studied thereflection of light and invented a trifocal light mirror. Moreover, he also invented an apparatus for producing a vacuum without the need for a pneumo-barometer machine. His other inventions include a clock marking World Time. At numerous occasions, he described the vast number of ways in which maths was used in his work.

Georado, Edward. "National Hispanic Month: Five Hispanic and Latino Mathematicians." DreamBox Learning, 11 Oct. 2016, www.dreambox.com/blog/five-hispanic-and-latino-mathematicians.

AFRICA

David Blackwell

David Harold Blackwell broke racial barriers when he was named (1965) the first African American member of the U.S. National Academy of Sciences. Blackwell pioneered game theory by analyzing the optimum timing of theoretical armed duelists. Blackwell was elected (1976) an honorary fellow of the Royal Statistical Society and won the John von Neumann Theory Prize in 1979.

Chike Obi

Dr. Chike Obi as suggested by the African Mathematics Union was the first Nigerian to hold a doctorate in mathematics. Prof. Chike Obi, has given scientific proof to a 361-year old mathematical puzzle known as Fermat's Last Theorem.He won the Ecklund Prize from the International Centre for Theoretical Physics for original work in Differential Equations, and pioneering works in Mathematics in Africa.

James Ezeilo

James Ezeilo was the first professor of mathematics in Nigeria. He was often regarded as the father of modern mathematics in Nigeria. He pioneered the use of Leray-Schauder degree type arguments to obtain existence results for periodic solutions of ordinary differential equations. Dr. James Ezeilo's early research dealt mainly with the problem of stability, boundedness, and convergence of solutions of third order ordinary differential equations.

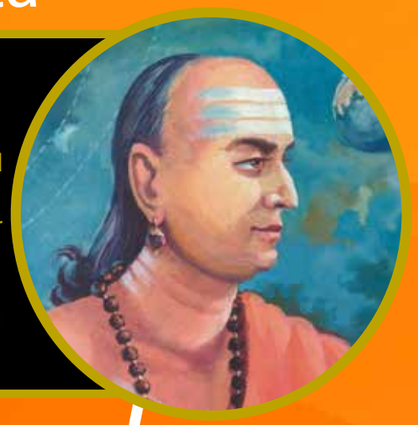
KatherineJohnson

Katherine Coleman Goble Johnson (born August 26, 1918) is an African-American mathematician whose calculations of orbital mechanics as a NASA employee were critical to the success of the first and subsequent U.S. manned spaceflights.Her work included calculating trajectories, launch windows and emergency return paths for Project Mercury spaceflights, for astronauts including Alan Shepard, the first American in space.

Molin, Paulina. "Who Are the Greatest African Mathematicians?" African Mathematicians, 23 Aug. 2017, www.math.buffalo.edu/mad/madgreatest.html.

ASIA

Aryabhatta



He is known best for the 'Aryabhatiya', a treatise containing 108 verses. These verses cover several branches of mathematics such as algebra, arithmetic, plane and spherical trigonometry. Also included in them are theories on continued fractions, sum of power series, sine tables and quadratic equations. While he will always be remembered for the rather iconic introduction of '0' into mathematics, he also came up with an approximation of pi and the area of a triangle. In addition, he introduced the concept of sine in his work called the 'Ardha-jya' (literally translated as 'half-chord').

Liu Hui

All that is known about the life of Liu Hui is that he lived in the northern Wei kingdom during the 3rd century CE. Liu Hui published a book in 263 AD which contained the solutions to mathematical problems in the well-known Chinese book titled "The Nine Chapters on the Mathematical Art". He is classified as one of the most famous mathematicians of ancient China his mathematical findings and interests are still valued by the world.

Srinivasa Ramanujan

This renowned mathematician received no formal education in mathematics, so he began developing his own theorems. As his genius gained recognition, he was given the opportunity of travelling to England in 1914 where renowned British mathematician Godfrey H. Hardy tutored and collaborated with him in research. Post this, he made several advances in mathematics publishing various papers in many European journals. His work focussed on analysis, game theory and infinite series. He also described in detail the mock theta function, a concept of mock modular form in mathematics.

Omar Khayyam

This Persian mathematician, philosopher, poet and astronomer was born in 1048 in modern day Iran. He began his career teaching algebra and geometry. His popular works include his highly influential mathematical treatise called 'Treatise on Demonstration of Problems of Algebra' which he completed in 1070. This, along with his many other works, highly influenced the development of mathematics in the world. He also laid the foundations of the Pascal's triangle with his work on the triangular array of binomial coefficients.

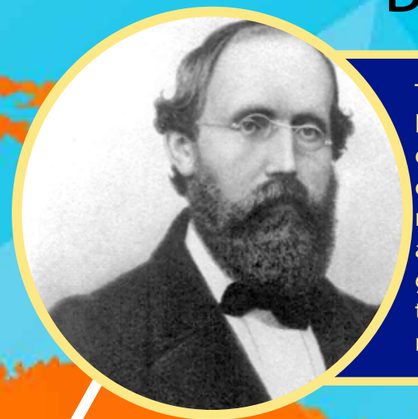
Gangolli, Ramesh. "Asian Contributions to Mathematics ." Asian Contributions to Mathematics , 23 Aug. 2018, www.pps.k12.or.us/depts-c/mc-me/be-as-ma.pdf.

EUROPE

Abraham De Moivre

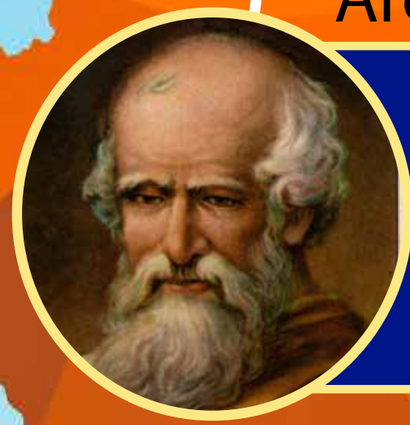
It was his father's belief in education which helped him to gain quality education. However, he was still unable to secure a degree in mathematics. His realisation of the fact that he had much more to learn provided him with the thrust to become "the pioneer in the development of analytic trigonometry and [the] theory of probability." De Moivre was one of the first mathematicians to introduce complex numbers in trigonometry. The theorem known by his name, was instrumental in bridging trigonometry with analysis.

Bernhard Reinmann



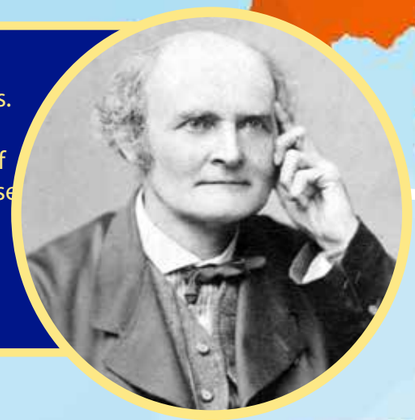
This gifted mathematician was from Germany had has exceptional calculational aptitude. He had an extraordinary command over complex analysis, which he combined with topology and number theory. His other revolutionary contributions were in differential geometry and the most notable, theory of manifolds. His work generalized the notions of distance and curvature. Several theorems, such as the Riemann-Roch, theorem have been named after him.

Archimedes



Archimedes of Syracuse contributed significantly to several academic categories, thus, earning him the qualifications of a mathematician, physicist, inventor, engineer and astronomer. One of his most famous mathematical discoveries is his work on the volumes of irregular shapes. He was also the person behind the proof of the area of a circle (pi multiplied by radius squared). Some of his mathematical works include 'On the Sphere and Cylinder', 'Measurement of a Circle' and 'The Quadrature of the Parabola'. Archimedes will always be remembered for establishing the foundations of various mathematical fields.

Arthur Cayley



Arthur Cayley was a British mathematician and lawyer who wrote more than three hundred mathematical papers. He worked in collaboration with his contemporary James Joseph Sylvester and together they laid the foundations of the algebraic theory of variants. He also published a treatise on 'Elliptic Functions' in 1876 and wrote several memoirs on analytical geometry, theory of determinants, theory of Matrices and skew surfaces. His works are immensely valuable in the study of advanced mathematics.

Johnson, Maria. "Prominent European Mathematicians." Prominent European Mathematicians, 21 Aug. 2018, www2.onu.edu/~m-caragiu.1/bonus_files/Names.pdf.

AUSTRALIA

Akshay Venkatesh

At 16, Prof. Venkatesh became the youngest person ever to earn first class honours in pure mathematics from the University of Western Australia. He is a fields medal laureate and completed his PhD from Princeton in 2002. He is regarded as a child prodigy in mathematics after he won a bronze medal in the 1994 Hong Kong IMO at the age of 12.

Terrence Tao

In 2004, Dr. Tao, along with Ben Green, solved a problem related to the Twin Prime Conjecture by looking at prime number progressions—series of prime numbers equally spaced from each other. (For example, 3, 7 and 11 constitute a progression of prime numbers with a spacing of 4; the next number in the sequence, 15, is not prime.) Dr. Tao and Dr. Green proved that somewhere in the infinity of integers, a progression of prime numbers of equal spacing and any length always exists.

Ernie Tuck

Dr. Ernie Tuck is renowned in Australia for his Ship Motion Program and Tuck's imcompressibity function. In 1968, he was appointed the Elder Professor of Mathematics in Adelaide University. In 1992, he established TeXAdel, an organization responsible for automating the production of the AMS journals.

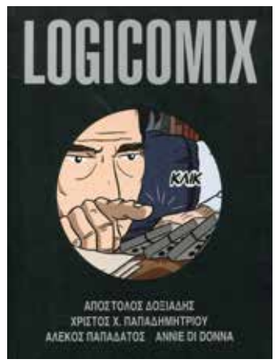
Diana Shelstad

Shelstad has been a key player in the development of the theory of endoscopy which is part of Langlands program. She co-conjectured the fundamental dilemma with Robert Langlands in 1984. After over 20 years, this conjecture was solved by Ngô Bao Châu in 2009, thus opening up a number of research opportunities in the field.

Mauds, Sehan. "Famous Mathematicians from Australia." Ranker, 20 Oct. 2017, www.ranker.com/list/famous-mathematicians-from-australia/reference.

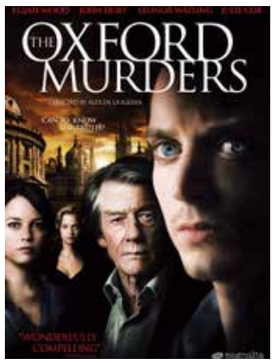
THE MATHEMATICIAN'S CHECKLIST

Handpicked entertaintment to cherish this Founder's Break!



Logicomix: An Epic Search for Truth is a graphic novel about the foundational quest in mathematics, written by Apostolos Doxiadis, author of Uncle Petros and Goldbach's Conjecture, and computer scientist Christos Papadi of the University of California. Character design and artwork are by Alecos Papadatos. The book was originally written in English, and was translated into Greek by author Apostolos Doxiadis for the release in Greece, which preceded the UK and U.S.releases.

The Oxford Murders is a 2008 British-Spanish thriller film from the novel, "Oxford Murders" by the Argentine mathematician and writer Guillermo Martínez. The film stars Elijah Wood, Julie Cox and Leonor Watling, a Spanish actress. The plot revolves around the attempts of an Oxford graduate student and his professor to stop a potential series of murders seemingly linked by mathematical symbols. Full of varoius mathemaical references, this film is a must-watch for all.



Mustafa, Genia. "Logicomix." Bloomsbury Publishing, 21 Aug. 2017, www.bloomsbury.com/uk/logicomix-9780747597209/.

CHALLENGE YOURSELF

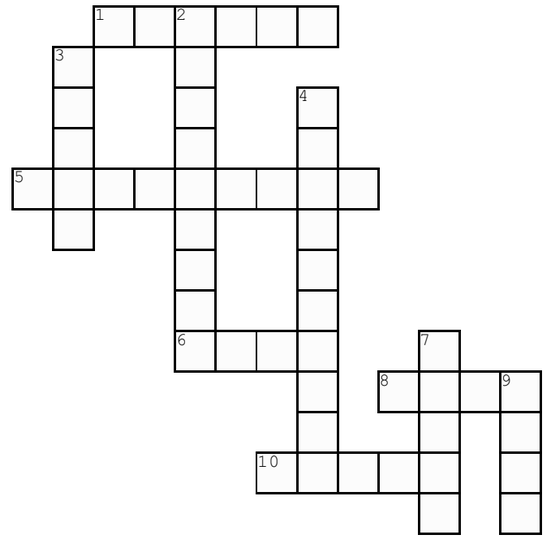
Sudoku

			2	6		7		1
6	8			7			9	
1	9				4	5		
8	2		1				4	
		4	6		2	9		
	5				3		2	8
		9	3				7	4
	4			5			3	6
7		3		1	8			

Sudoku puzzle created at www.theteacherscorner.net

Famous Mathematicians

All answers to this crossword are the concerned persons' surnames.



Created with TheTeachersCorner.net Crossword Puzzle Generator

Across

1. This French mathematician was Fluent in six languages (French, Latin, Occitan, classical Greek, Italian and Spanish)
5. Author of How Not To Be Wrong
6. This mathematician graduated with both a B.S. and M,S. in mathematics at the age of 19
8. He was a member of the Statistical Research Group (SRG) where he applied his statistical skills to various wartime problems
10. He was appointed as the first Regius Professor of Mathematics at Oxford this year

Down

2. His birthday is celebrated as the Indian National Mathematics Day every year
3. This mathematician opened his own school in Lincolnshire
4. This Iranian Fields Medal awardee died of breast cancer last year at the age of 40
7. He is known as the the greatest mathematician since antiquity
9. This Indian mathematician is known as the human computer

THE LEGEN D LIVES ON

Richard M. Pollack

1935-2018 (83 years)

Richard M. Pollack was an American mathematician and professor at New York's Courant Institute, from where he also earned his PhD. He made significant contributions to combinatorics, real algebraic geometry and discrete geometry. These can be seen in his extension of the Hadwiger transversal theorem to multiple dimensions and a proof of the first non trivial bounds on the number of order types and polytopes. In association with Jacob E. Goodman, he also founded Discrete and Computational Geometry, a peer-reviewed international journal of mathematics and computer science, in 1986. Interestingly, he has also worked with Paul Erdős and thus, has the extremely rare Erdős number of 1. A fellow of the American Mathematical Society, Pollack passed away on the 18th of September, 2018.

Richard Kadison

1925-2018 (93 years)

Richard Kadison was an American mathematician who was awarded the Steele Prize for Lifetime Achievement in 1999. He completed his PhD from the University of Chicago and held two posts: a member of the faculty at the University of Columbia and the Gustave C. Kuemmerle professor at the University of Pennsylvania (which he held till his death on the 22nd of August, 2018). He is known for his contribution to the field of operator algebras, and for the formulation of the Kadison's inequality and the Kadison-Singer problem. According to editors S. Doran and Efton Park, his research was 'fundamental in the development of the subject, and his influence continues to be felt through his work and the work of many of his students, collaborators, and mentees'.

Philip M. Woodward

1919-2018 (98 years)

Philip M. Woodward was known for his work in probability and radar signal analysis. He worked as Deputy Chief Scientific officer at the Royal Signal and Radar Establishment (RSRE) of the British Ministry of Defence. He applied several mathematical techniques such as Bayesian probabilities and mathematical beam shaping to bring about pioneering advances in radar technology. In 2009, he was honoured with the Picard medal for Radar Technologies and Applications for his formulation of the Woodward Ambiguity function. He was responsible for the construction of the W5 clock, which was described by Jonathan Betts, senior curator of horology at the Royal Observatory of Greenwich as "the nearest approach to perfection by any mechanical timekeeper."

Anatole Katok

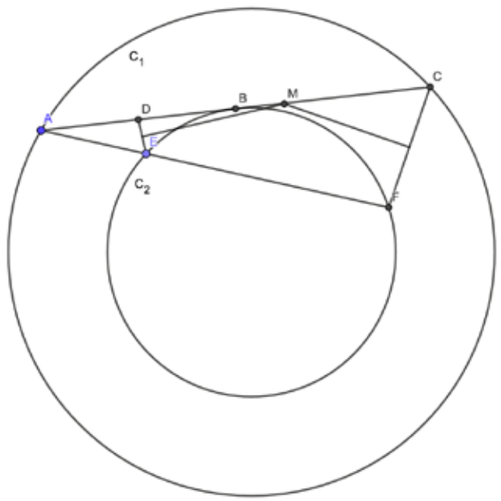
1944-2018 (74 years)

Anatole Katok was a Raymond N. Shibley professor of mathematics at the University of Pennsylvania and was honoured with the Michael Brin prize in dynamical systems. Before working at the University of Pennsylvania, he also held posts at the California Institute of Technology and the University of Maryland. He is known for his study in the field of dynamical systems and the classification of such systems into parabolic, hyperbolic and elliptic categories. He is also recognised for his works in areas of modern mathematics such as chaos theory and ergodic theory. He was described by University of Chicago president Robert J. Zimmer as a "whirlwind of mathematical activity … [who] … brought new connections and engaged all around him with an infectious and buoyant enthusiasm for mathematics and its mysteries."

"American Mathematical Society." AMS, American Mathematical Society, www.ams.org/publicoutreach/in-memory/in-memory. "Anatole Katok, Mathematician Who Explored Chaos Theory, Dies at 73." The Washington Post, WP Company, 9 May 2018, www.washingtonpost.com/local/obituaries/anatole-katok-mathematician-who-explored-chaos-theory-dies-at-73/2018/05/09/"Anatole Katok." Basic Chemistry: Atoms and Ions, personal.psu.edu/axk29/."Philip M. Woodward." Philip M. Woodward | Aerospace & Electronic Systems Society, ieee-aess.org/contact/philip-m-woodward.

PROBLEMS TO PONDER OVER

1. Let C_1 and C_2 be concentric circles with C_2 inside C_1. Let A and C be on C_1 such that AC is tangent to C_2 at B. Let D be the midpoint of AB. A line passing through A meets C_2 at E and F such that the perpendicular bisectors of DE and CF meet at a point M on segment DC. Find the ratio AM/MC.



2. Let $a_n = \frac{(2^3-1)}{(2^3+1)} \cdot \frac{(3^3-1)}{(3^3+1)} \cdot \frac{(4^3-1)}{(4^3+1)} \cdots \frac{(n^3-1)}{(n^3+1)}$

Find $\lim_{n\to\infty} a_n$

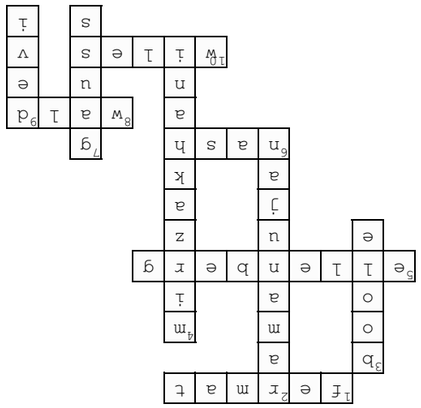
3. Suppose a large number of particles are bouncing back and forth between x=0 and x=1, except that at each endpoint some escape. Let r be the fraction reflected each time; then (1-r) is the fraction escaping. Suppose the particles start at x=0 heading toward x=1; eventually all particles will escape. What is the largest fraction of the particles which can escape at x = 0?

4. Which solid - cube or cuboid - has a higher volume if the sum of lengths of all edges are equal?

5. Find $\lim_{n\to\infty} n \sin\left(\frac{1}{n}\right)$

ANSWERS

9	5	2	8	1	4	3	7
6	3	1	7	5	9	8	2
4	7	8	6	2	3	9	5
8	2	6	3	4	7	5	9
5	1	9	2	8	6	7	3
7	4	3	5	9	1	6	8
2	6	5	4	3	8	9	1
3	9	4	1	7	5	2	6
1	8	7	9	6	2	5	4



(Ans 1: 5/3) (Ans 2: 2/3) (Ans 3: 1/2) (Ans 4: Cube) (Ans 5: I)

Boas, Mary L. Mathematical Methods in the Physical Sciences. Wiley-India, 2010. Art of Problem Solving. artofproblemsolving.com/.Arthur. Problem Solving Strategies.

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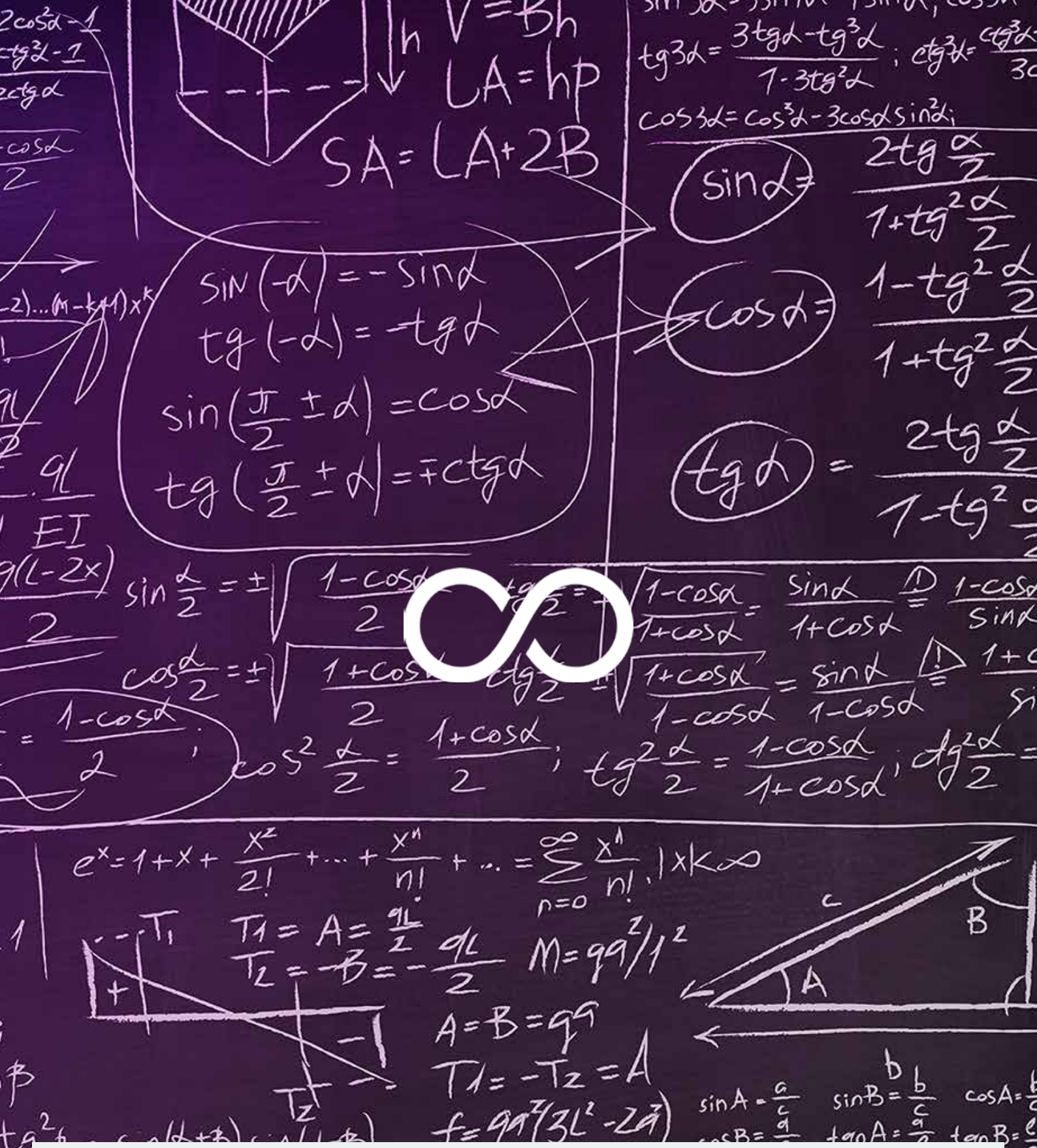

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