Department of Mathematics
IIT Kharagpur

XPONENT
2018

11h Edition

XPONENT 2018

DEPARTMENT OF
MATHEMATICS IIT KHARAGPUR

ACKNOWLEDGEMENT

We would like to take this opportunity to extend our heartfelt gratitude to all the members of the department, students and faculty alike, whose response to previous editions of the Xponent has motivated us to no limits. We would like to thank Head of the Department, Prof. M.P.Biswal, and the Professor-in-Charge of the Colloquium, Prof. R.K.Pandey, who had been most supportive of every Colloquium initiative.

FROM THE PRESIDENT’S DESK

On the behalf of The Mathematics Colloquium team, I am pleased to present to you the eleventh edition of Xponent. It couldn't have been possible without the efforts of and enthusiasm shown by the whole team. Congratulations to all of you.

As I reach the end of my tenure, looking back, it seems only yesterday that the baton was passed over to me. Time flies!

An year has passed and the time has come for me to pass on the baton, as is the custom. A big thank you! To all, who came and enjoyed the events. To all, who helped in organizing them. We started off by Freshers’ Introduction followed up by the Teachers’ day celebrations. Career Fundae session conducted for pre-final and final year students and talks conducted by in-house faculty were much appreciated. I would hereby also request the readers if they can come up with innovative ideas for more effective student-faculty interactions outside of class that remains our primary aim.

It has been a wonderful year; a unique learning experience both personally for me and for the club as well. The Mathematics Colloquium, in general, is fun and by being at the helm of a hobby club, I did out best for upholding the culture in the institute. I extend my sincere gratitude for being a part of our events and making them awesome.

Signing off is mixed feeling. You feel happy for what you have achieved in the tenure but simultaneously you feel sad for missing the family you have been part of for so long. My best wishes to the next team and hope they take the club to new heights.

Signing off,

Hareesh Kulakarni Narravula
President
The Mathematics Colloquium

EDITORIAL

Welcome to the 11th edition of Xponent. Hope it brings something for every reader interested in mathematics. Over eleven years ago, the Mathematics Colloquium started to publish a magazine. And here you hold the 11th incarnation of the same.

We have articles on Zero knowledge which presents some very interesting puzzles and their solutions. It includes a way of long distance coin tossing and how to introduce random elements in a proportion of answers to private personal information. We play with some tiles to generate various shapes and then wonder how trigonometry was used thousands of years ago.

While writing this magazine I realised how daunting a task it is. It required a lot of research and time to complete this magazine. I would also like to thank everyone who helped me providing with their resources and guidance.

Lastly, I wish the departing batch a very good luck for their future and am confident that they will be successful in their endeavours and make the department and IIT Kharagpur proud. I feel proud to hand over to you this Nostalgic Memorabilia.

Himanshu
Editor
The Mathematics Colloquium

CONTENTS

ARTICLES

ZERO KNOWLEDGE

PUZZLE   I have a dozen warring, but mathematics loving, relatives who never get together. And I have a fortune amassed and stored in my safe. I am willing to give away the three-digit code to the safe and thus all 12 gold bars in it, one per relative, if all will come together, finally, for once, to meet and cooperate on a task. Actually, I will settle for just ten or eleven coming together, each taking a bar, and using the remaining bars to cover the costs of a blow-out party. How could I send each of my relatives a clue to the safe number so that only if some subset of ten of them come together they will have, as a group, enough information to deduce that number?

It often happens in mathematics that one can prove certain numbers or objects exist, but be unable to give the slightest clue as to what they actually are or how you might go about finding them. This is an example.

There exist two non-bald people in New York City each with exactly the same number of hairs on their heads.

Proof: According to Google, the average number of hairs on a human head is about 100,000. So I can safely assume that no New Yorker has a million or more head hairs. But there are more than a million non-bald New Yorkers and they can't all have a different number of hairs. Thus there must exist at least two New Yorkers with exactly the same head hair count. Challenge: Find two New Yorkers with the same number of hairs on their heads.

Another "zero-knowledge" challenge might come from mathematical coyness. Suppose I want to convince you that I know the solution to a problem, but I don't want to give you any clue as to what the solution is. (These sorts of matters often arise in the study of cryptography.)

Such actions can often be done. Here's a simple example. In the game of "Where's Waldo?" one is presented with a very complicated picture of a crowd scene, with hundreds of different figures drawn throughout the page. Your job is to find the one figure – Waldo – wearing a distinctive red and white striped shirt and hat. I know where Waldo is in this picture. And I could prove to you that I know and not give you a hint as to where he is as I prove to you I have this knowledge. Here's how. I'll take a big sheet of paper and cut a small hole in it, just the size of Waldo. Then you can watch me take a copy of the picture, slide it under the sheet and arrange it so that Waldo's image appears through the hole. You can verify that I have indeed shown you Waldo, but you can't see where on this picture that image lies. Voila!

Long-Distance Coin Tossing: Alberto lives on the east coast of the U.S., Beatrice on the west coast. During a telephone conversation they decide they need to toss a coin in order to decide who is going to follow through on a fun and exciting task. Alberto says he'll toss a coin and if it comes up heads, he wins, if it comes up tails, Beatrice wins. Beatrice, of course, objects to this plan, as she will not be able to see the coin toss and verify that Alberto is telling the truth about the result. So Beatrice offers this plan: She will first write on a piece of paper either "heads" or "tails" and commit to the choice. Then Alberto will toss the coin and announce the result. If Beatrice's prediction matches the toss, she wins, if it does not, Alberto wins. Now Alberto has no incentive to lie about the coin toss, but will object to this process as he has no way of telling if Beatrice lies about the prediction she made. So how could Alberto and Beatrice possibly conduct the action of a long-distance coin toss and feel confident that the other person was not lying at any stage of the process?

Answer: Forget the coin and try this instead. Alberto thinks of two large prime numbers p and q , one that is 1 more than a multiple of four and the other 3 more than a multiple of four. He then computes N pq , their product, and shares that product with Beatrice over the phone. Alberto is thus committed to that number. Because it is computationally infeasible to factor N , Beatrice cannot tell what the two primes are. Beatrice will then say out loud either the statement "The larger of the two primes is the one that is 1 more than a multiple of four." She commits to that statement. Alberto now reveals the two primes p and q and both can verify that they are indeed primes (this is computationally feasible), have the required remainder properties, that their product is N, and whether or not Beatrice's guess was right or wrong to win or lose this virtual coin toss.

COIN TOSSES AND PERSONAL INFORMATION

The mathematics department at a college is wondering just how rampant cheating on math exams is across campus. What percentage of students cheat? They would like to conduct a survey asking students "Have you cheated on a math exam this past year?" but know full well no one is going to honestly answer YES when faced with this question and nothing more. So how could the department garner the percentage of students that cheat by still asking this question, but assuring the students that in no way a "YES, I have cheated" answer can possibly be held as evidence against them for cheating? One sets up the following protocol. Have student toss a coin. Those that toss heads are to answer the question honestly. Those that toss tails are to flip a coin again and answer YES to the question if this second toss lands heads and NO if it lands tails. Even if Cecile's name is mistakenly released with her answer to the question, one cannot hold her YES answer to cheating against her: she could well have been one of the 25% of the people instructed to answer YES because of the second toss of a coin. Similarly, Dilbert might well be an incessant cheater, but could be one of the 25% of the people instructed to answer NO by the random process. His cheating habits will remain unnoticed. So does this mean that survey results are of no use to the Mathematics Department? Imagine there are 2000 students on campus and the department received 620 answers of YES and 1380 answers of NO. Of those 2000 students, they expect close to a 1000 students answered the question honestly and 1000 to answer with the flip of a coin. In that second group, about 500 students answered YES and about 500 NO. Thus the department concludes that, among the 1000 students who answered honestly, about 120 answered YES, 880 answered NO. The percentage of students that have cheated is about 12%. (And yet, even if names are released with the survey results, the department still cannot identify a single cheater.) Question: Are techniques like these used by internet data gatherers? Do they introduce a random element into a proportion of answers logged? Is our personal information actually private after all?

THE OPENING PUZZLER

Here we have a situation of wanting large groups to have full knowledge of some piece of content, but all smaller groups to have zero knowledge. It is surprising that we can create such knowledge structure. Here's one way to do this for our example due to Israeli mathematician Adi Shamir.

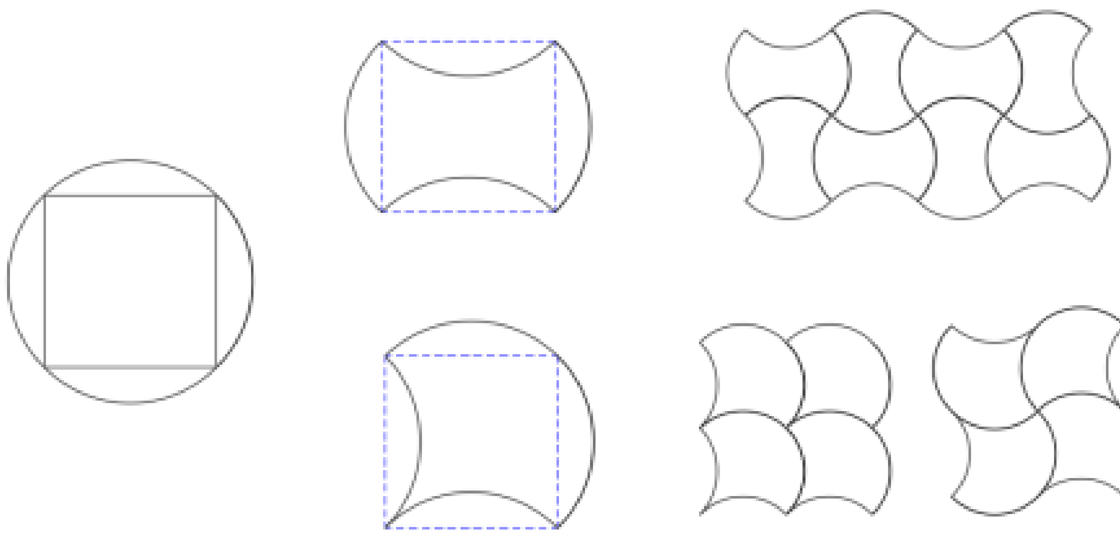
Shamir's Secret Sharing: It is well known that two points in the plane determine a unique line, three points a unique quadratic, and so on. In general, N points in the plane determine a unique polynomial of degree N 1 (provided no two of those points have the same x -coordinate).

So what I can do is write down some degree nine polynomial P with y -intercept the code number to my safe and then send each relative a letter explaining what I have done and include, to the i th relative, the value of P i . (Here i ranges from 1 to 12, though any set of twelve distinct non-zero values for i will do.) Only when ten or more relatives are together will they have ten data points to determine the polynomial, and hence its y -intercept.

Tiling with One Arc-Sided Shape

The Arc Approach

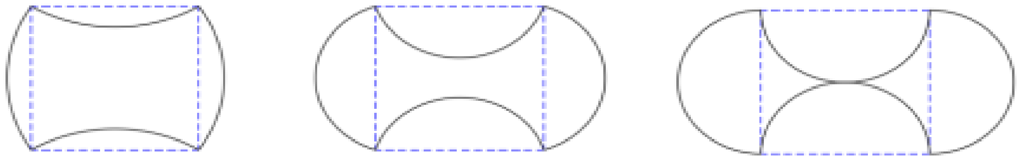
A flat puzzle (tiling) with dozens or hundreds of identical pieces may sound a little dull and predictable. But what is the most interesting shape we can use, to get the most unusual designs and the most variety? To make it more visually interesting, let's say we want a shape with no straight edges—only curves. The following guidelines should help us get started.



1. Let's use circular arcs, all with the same radius of a unit length. Hereafter we won't talk about lengths; just about angles. These are angles of the arcs and of the corner angles. For good tiling these angles need to be divisors of 360° such as multiples of 12° or 15°: "agreeable" angles.
2. Since the arcs must fit together there must be as much concave arc as convex arc.
3. We'll look at shapes that at least tile periodically—that is, by repeating it in simple translation—but are looking for tiles that fit together after rotation, with the more options the better.
4. Let's say we are free to use the reflection or mirror image of the shape. This might not seem important at first with symmetrical shapes but will be important later with more complex shapes and tilings.

Circling the Square

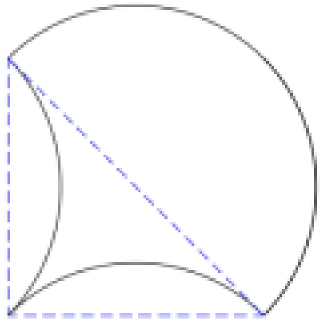
It is simplest to start with a square, since we can just replace the sides with two concave and two convex arcs, and get tiling based on adjacent squares as shown below. We can start with 90° arcs, which could encircle the square. The bottom shape below will show up again. It has been used for centuries. Since it is could be viewed as a stylized horseshoe crab, we'll call it the Crab.The arc angle can be any value up to 180°, as shown below.



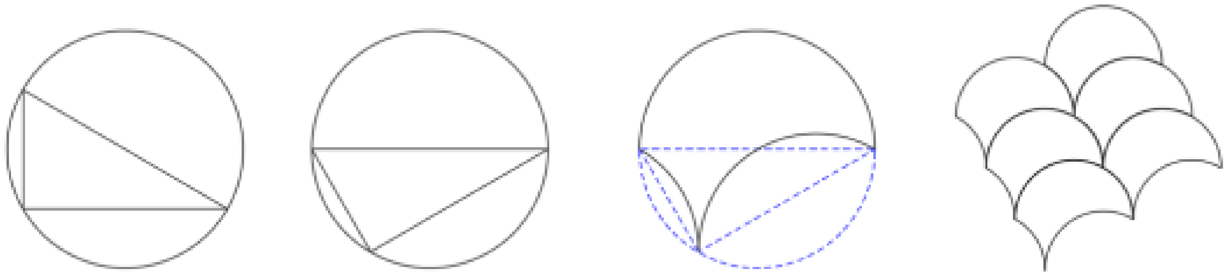
Trying Triangles

It we want to start with a triangle, it becomes more difficult due to the three sides. We can't just replace the three sides of an equilateral triangle with identical arcs, since we won't be able to get the same amount of convex and concave arc.

A 45° right triangle can be easily converted by putting a 180° arc on the hypotenuse, and 90° arcs on the two smaller sides. This gives us the Crab again.



Any right triangle can be converted to a tiling shape, by putting a convex 180° arc on the hypotenuse, and same-radius concave arcs on each of the smaller sides. This is because any right triangle can be inscribed in a half circle.

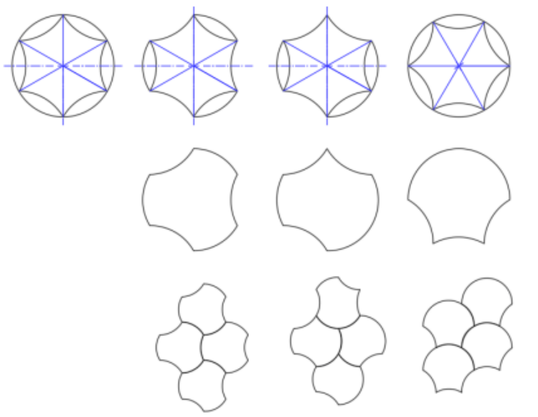


This shape can tile periodically, and some special cases–such as conversions from 45° and 30°/60° right triangles—result in shapes with agreeable angles that can also tile with rotations. But with all other right triangles we can’t easily get the final agreeable angles we want.

Coming Full Circle

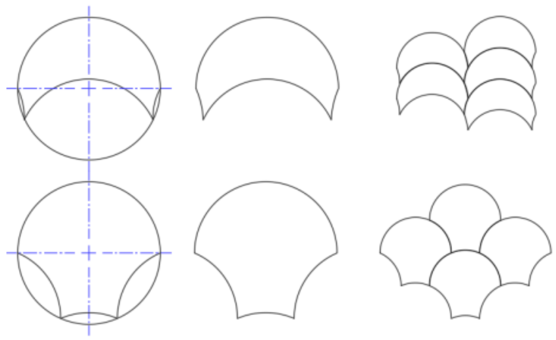
If we start with a whole circle, we will want to replace half the circumference with concave arcs. We could start with creating two 90° concave arcs, either opposite each other or next to each other–and get the two same shapes we got initially using squares.

We can also use three 60° concave arcs. This can be done in the three arrangements shown below.

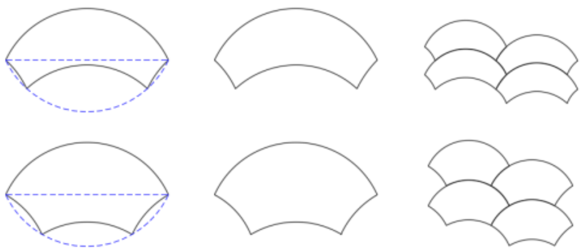


These shapes can also be made using a hexagon as the starting point.

The shape on the right above–with the three adjacent concave cutouts—can be modified with other sizes or concave arcs. If we stay symmetrical we can use various combinations of concave arcs totaling 180° as shown below. These will all tile in the same periodic manner. If the bottom middle cutout is reduced to nothing, we will have just two 90° concave arcs: the Crab again.



This approach with three concave cutouts in the lower half can also be used based on a lens shape. The lens is created by taking one arc (up to 180 degrees) and mirroring it about its endpoints. This is the more general case of the circle. As we did with the circle, we can make three concave cutouts bounded by one of the arcs, with similar periodic tiling.

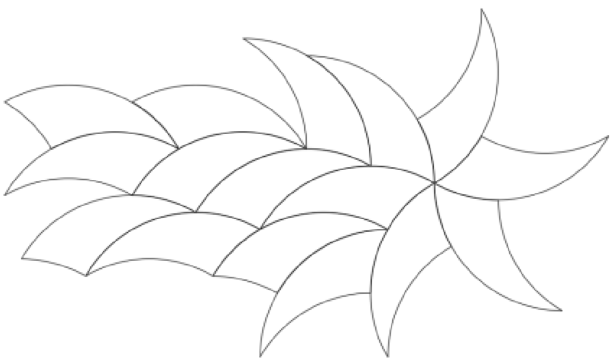


All the shapes here primarily tile predictably and periodically, albeit with a wide range of possible arc angles and corner angles. Some of them can fit together in more complex ways, with rotation and more choices for tiling. How can we get the most flexibility from a single shape; or better, from a family of shapes?

Trifocal Lenses

The shape family with the most overall flexibility has three sides. But is not constructed from a triangle; rather it starts with the desired corner angles or arcs in the framework of a lens shape.

Let's say we want a triangle-like shape with the usable corner angles of 30° and 60°. These will also be the angles of the two concave arcs. We could start construction with these, but it's easier to start with the large-arc lens which will be the sum of these, or 90°. So we make a 90° arc and mirror it to make a lens shape. Then mark two smaller arcs—where they meet on the mirrored arc—and mirror each of them about their endpoints. The resulting shape allows surprising flexibility for tiling.



The big advantage with this approach is that we choose the corner angles first, and the rest follows. If we want to build tiling around 5-pointed stars or flowers, we can choose small angles of, say, 36° and 72°.

Assuming we use reasonable angles, this construction and tiling works for any large angle up to 180°, and any proportioning of the two smaller arcs. The corner angle opposite the large convex arc is always the supplement (difference from 180°) of the large arc. And the smaller corner angles are always the same as the concave arcs.

Conclusion

The above approach lets us make a wide range of shapes, with complex and varied tilings that are radial/polar, periodic, or non-periodic, or some combination of these. This new family of shapes we can call tricurves.

Hints of Trigonometry on a 3,700-Year-Old Babylonian Tablet

Suppose that a ramp leading to the top of a ziggurat wall is 56 cubits long, and the vertical height of the ziggurat is 45 cubits. What is the distance x from the outside base of the ramp to the point directly below the top? (Ziggurats were terraced pyramids built in the ancient Middle East; a cubit is a length of measure equal to about 18 inches or 44 centimeters.)

Could the Babylonians who lived in what is now Iraq more than 3,700 years ago solve a word problem like this?

Two Australian mathematicians assert that an ancient clay tablet was a tool for working out trigonometry problems, possibly adding to the many techniques that Babylonian mathematicians had mastered.

"It's a trigonometric table, which is 3,000 years ahead of its time," said Daniel F. Mansfield of the University of New South Wales. Dr. Mansfield and his colleague Norman J. Wildberger reported their findings in the journal Historia Mathematica.

The tablet, known as Plimpton 322, was discovered in the early 1900s in southern Iraq and has long been of interest to scholars. It contains 60 numbers organized into 15 rows and four columns inscribed on a piece of clay about 5 inches wide and 3.5 inches tall. It eventually entered the collection of George Arthur Plimpton, an American publisher, who later donated his collection to Columbia University. With all the publicity, the tablet has been put on display at the university's Rare Book & Manuscript Library.

Based on the style of cuneiform script used for the numbers, Plimpton 322 has been dated to between 1822 and 1762 B.C.

One of the columns on Plimpton 322 is just a numbering of the rows from 1 to 15.

The other three columns are much more intriguing. In the 1940s, Otto E. Neugebauer and Abraham J. Sachs, mathematics historians, pointed out that the other three columns were essentially Pythagorean triples — sets of integers, or whole numbers, that satisfy the equation $a^2 + b^2 = c^2$.

That by itself was remarkable given that the Greek mathematician Pythagoras, for whom the triples were named, would not be born for another thousand years.

Why the Babylonians compiled the triples and wrote them down has remained a matter of debate. One interpretation was that it helped teachers generate and check problems for students.

Dr. Mansfield, who was searching for examples of ancient mathematics to intrigue his students, came across Plimpton 322 and found the previous explanations unsatisfying. “None of them really seemed to nail it,” he said.

Other researchers have postulated that the tablet originally had additional columns listing ratios of the sides. (There’s a break along the left side of the tablet.)

But what is conspicuously missing is the notion of angle, the central concept impressed upon students learning trigonometry today. Dr. Wildberger, down the hall from Dr. Mansfield, had a decade earlier proposed teaching trigonometry in terms of ratios rather than angles, and the two wondered that Babylonians took a similar angle-less approach to trigonometry.

Perhaps the strongest argument in favor of the hypothesis of Dr. Mansfield and Dr. Wildberger is that the table works for trigonometric calculations, that someone had put in the effort to generate Pythagorean triples to describe right triangles at roughly one-degree increments.

“You don’t make a trigonometric table by accident,” Dr. Mansfield said. “Just having a list of Pythagorean triples doesn’t help you much. That’s just a list of numbers. But when you arrange it in such a way so that you can use any known ratio of a triangle to find the other sides of a triangle, then it becomes trigonometry. That’s what we can use this fragment for.”

A Babylonian faced with the ziggurat word problem may have found it easy to set up: a right triangle with the long side, or hypotenuse, 56 cubits long, and one of the shorter sides 45 cubits. Next, the problem solver could have calculated the ratio 56/45, or about 1.244 and then looked up the closest entry on the table, which is line 11, which lists the ratio 1.25.

From that line, it is then a straightforward calculation to produce an answer of 33.6 cubits. In their paper, Dr. Mansfield and Dr. Wildberger show that this is better than what would be calculated using a trigonometric table from the Indian mathematician Madhava 3,000 years later.

These days, someone with a calculator can quickly come up with a bit more accurate answer: 33.3317.

SIMPSONS AND MATHEMATICS

Without doubt, the most mathematically sophisticated television show in the history of primetime broadcasting is *The Simpsons*. This is not a figment of my deranged mind, which admittedly is obsessed with both *The Simpsons* and mathematics, but rather it is a concrete claim backed up in a series of remarkable episodes.

The first proper episode of the series in 1989 contained numerous mathematical references (including a joke about calculus), while the infamous "Treehouse of Horror VI" episode presents the most intense five minutes of mathematics ever broadcast to a mass audience. Moreover, *The Simpsons* has even offered viewers an obscure joke about Fermat's Last Theorem, the most notorious equation in the history of mathematics.

These examples are just the tip of the iceberg, because the show's writing team includes several mathematical heavyweights. Al Jean, who worked on the first series and is now executive producer, went to Harvard University to study mathematics at the age of just 16. Others have similarly impressive degrees in maths, a few can even boast PhDs, and Jeff Westbrook resigned from a senior research post at Yale University to write scripts for Homer, Marge and the other residents of Springfield. (Simpsons writer Al Jean, third from

left in the back row, in the mathematics team from 1977 Roeper School yearbook.
Photograph:

Courtesy of Al Jean)

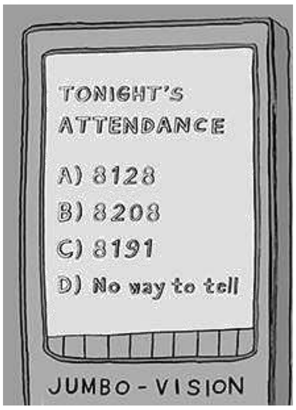
When they moved from academia to Fox Studios, these writers retained their passion for numbers and they have secretly planted mathematical references in dozens of episodes. Until now, only extreme geeks have been aware that the writers have been smuggling mathematics into their scripts while the rest of the planet has been oblivious to the numerous nods to number theory and geometry.

The 2006 episode "Marge and Homer turn a Couple Play" for example, contains a triple dose of secret mathematics. The storyline revolves around Marge and Homer's efforts to help baseball star Buck Mitchell and his wife Tabitha Vixx, who are experiencing marital difficulties. The episode climaxes with Tabitha appearing on the Jumbo Vision screen at the Springfield stadium, where she publicly proclaims her love for Buck. More important, just before she appears on the screen, it displays a question that asks the baseball fans in the crowd to guess the attendance.

The Jumbo Vision screen from 'Marge and Homer Turn a Couple Play', showing a perfect number, a narcissistic number and a Mersenne prime number.

The screen displays three multiple choice options; 8,128, 8,208 and 8,191. These digits might seem arbitrary and innocuous, but in fact they represent a perfect number, a narcissistic number and a Mersenne Prime.

8,128 is called a perfect number, because its divisors add up to the number itself. The smallest perfect number is 6, because 1, 2 and 3 not only divide into 6, but they also add up to 6. The second perfect number is 28, because 1, 2, 4, 7 and 14 not only divide into 28, but they also add up to 28. The third perfect number is 496, and the fourth one is 8,128, which appears in this episode. As René Descartes, the 17th-century French mathematician (and philosopher) pointed out: "Perfect numbers, like perfect men, are very rare."



8,208 is a narcissistic number because it contains 4 digits, and raising each of these digits to the 4th power generates four numbers that add up to itself: $8^4 + 2^4 + 0^4 + 8^4 = 8{,}208$.

The fact that 8,208 can recreate itself from its own components hints that the number is in love with itself, hence the narcissistic label. Among the infinity of numbers, fewer than 100 exhibit narcissism.

8,191 is a prime number, because it has no divisors other than 1 and the number itself, and it is labelled a Mersenne prime because another 17th-century French mathematician, Marin Mersenne, spotted that 8,191 was

equal to $2^{13} – 1$. More generally, Mersenne primes fit the pattern $2^p –1$, where p is any prime number.

Not surprisingly, several of the mathematical quips in *The Simpsons* relate to Homer and Marge's daughter, Lisa. She is proud to be a nerd and her grasp of everything from trigonometry to logarithms is recognized by Principal Skinner in the episode "Treehouse of Horror X" (1999). After a stack of bench seats falls on Lisa, he cries out: "She's been crushed! And so, have the hopes of our Mathletics team."

In "Money Bart", much of the episode is dedicated to Lisa's ruthlessly mathematical approach to coaching a winning baseball team. The entire storyline is rooted in statistics, but the most significant nerd reference appears and disappears in a blink of an eye. Just before her first big game in charge, we see Lisa poring over piles of technical books. This extraordinary sight prompts a reporter to remark: "I haven't seen these many books in a dugout since Albert Einstein went canoeing." Those who concentrate hard enough will spot that one of the books is titled "$e^{i\pi} + 1 = 0$". To the untrained eye, this is just another random equation. To the mathematical eye, this is the single most beautiful equation in history, because it combines five of the fundamental ingredients of mathematics (0, 1, e, i, and π) in one elegant recipe. It is known as Euler's identity, and named after the 18th-century Swiss genius Leonhard Euler.

When I met the writers in Los Angeles last year, they explained that this reference to Euler's identity is a perfect example of a freeze-frame gag, a form of humor that was largely developed by the show's writing team. Freeze-frame gags are visual quips that fly by unnoticed during the normal course of viewing, but which become more obvious when the program is paused.

To some extent, the freeze-frame gag was a product of technological developments. Roughly 65% of American households owned a video recorder by 1989, when *The Simpsons* was launched. This meant that fans could watch episodes several times and pause a scene when they had spotted something curious. Also, in 1989 more than 10% of households had a home computer and a few people even had access to the internet. The following year saw the birth of alt.tv.simpsons, a usenet newsgroup that allowed fans to share, among other things, their freeze-frame discoveries.

The writers relished the notion of the freeze-frame gag, because it enabled them to increase the comedic density. The mathematicians on the show were doubly keen because freeze-frame gags also gave them the opportunity to introduce obscure references that rewarded the hard-core number nerds.

My favorite freeze-frame gag appears in "The Wizard of Evergreen Terrace" (1998), in which Homer tries to become an inventor. In one scene, we see him busily scribbling equations on a blackboard. One of the equations relates to the mass of the Higgs boson, another concerns cosmology and the bottom line explores the geometry of doughnuts, but the most interesting equation is the second one, which appears to be a counterexample to Fermat's last theorem.

Although it was only on screen for a moment, this equation immediately caught my eye, because I have written a book on Fermat's last theorem. Homer's scribble sent a shiver down my spine. I was so shocked that I almost snapped my slide rule.

To appreciate my reaction, it is necessary to be aware of the colorful history behind Fermat's last theorem. In short, a 17th-century French mathematician called Pierre de Fermat believed that it was impossible to find numbers that fitted a particular equation, and he left a tantalizing note proclaiming that he had a proof of this fact, but he never wrote down the proof itself. For more than 300 years, mathematicians desperately tried and failed to rediscover Fermat's proof, which only made his inadvertent challenge even more infamous. Eventually, in the 1980s, Professor Andrew Wiles (now Sir Andrew Wiles) worked in secrecy for seven years to fulfil a childhood dream and build a proof that confirmed that Fermat was right, inasmuch as the following equation has no solution: $x^n + y^n = z^n$, for $n > 2$. It is neither necessary to understand the proof nor to examine the equation in detail, except I should stress again that both Wiles and Fermat claimed, indeed proved, that this equation has no solutions, yet Homer's blackboard proves the opposite!

$3987^{12} + 4365^{12} = 4472^{12}$.

Check it for yourself on your phone calculator and you will find that the equation balances! I realize that I have used two exclamation marks in two consecutive sentences, but this is an extraordinary mathematical circumstance. Homer had the audacity and genius to defy two of the greatest mathematicians in history.

Unfortunately, this is a "close but no cigar" moment for Homer. Although the numbers appear to work on a phone calculator with display of perhaps 10 digits, a closer inspection reveals that this is a so-called near miss solution. In other words, there is a minuscule margin of error, with the left side of the equation being 0.000000002% larger than the right side.

This prank was planted into the episode by David S Cohen, who later changed his name to David X Cohen, in part to reflect his love of algebra. Cohen joined the writing team of *The Simpsons* soon after completing a masters' degree in computer science at the University of California, Berkeley. While working on "The Wizard of Evergreen Terrace", Cohen took a break in order to write a computer program that would scan through values of x, y, z, and n until it found a pseudo-solution to Fermat's equation. (Simpsons writer David X Cohen pictured in the Dwight Morrow High School yearbook of 1984. Photograph: Courtesy of David X Cohen)

As soon as the episode aired, Cohen patrolled the online message boards to see if anybody had noticed his fake equation. He eventually spotted a posting that read: "I know this would seem to disprove Fermat's last theorem, but I typed it in my calculator and it worked. What in the world is going on here?"

In the late 1990s, Cohen worked with Matt Groening (creator of *The Simpsons*) to develop *Futurama*, an animated science fiction series set a thousand years into the future. He recruited some more mathematicians to join *Futurama's* writing team, including Ken Keeler whose doctoral thesis in applied mathematics was entitled "Map Representations and Optimal Encoding for Image Segmentation".

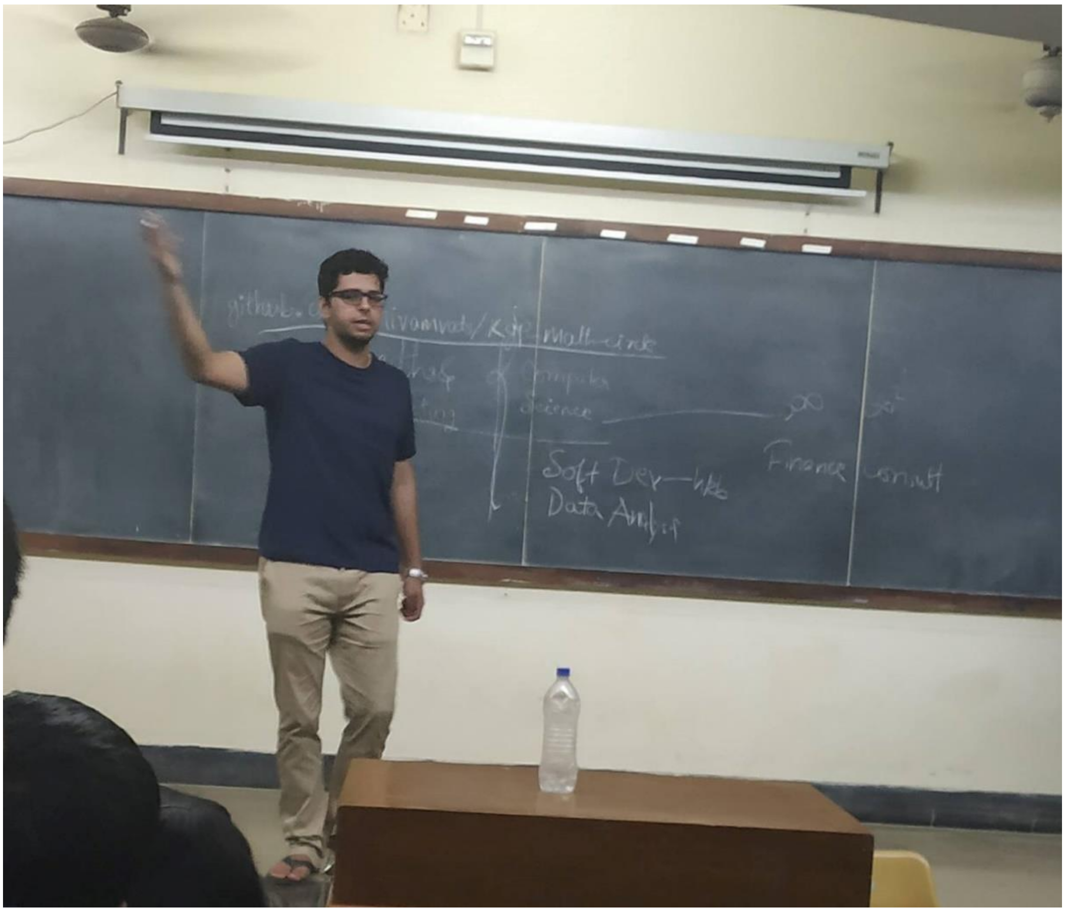
Not surprisingly, this sister series contained dozens of subtle mathematical references, including an indirect tribute to the great Indian mathematician Ramanujan, objects based on the geometry of the impossible Klein bottle, a freeze-frame gag about the unsolved P v NP problem, a script line about uncountable infinites and much more. Indeed, *Futurama* can boast the first piece of genuinely innovative and bespoke mathematics to have been created solely for the purposes of a comedy storyline.

Meanwhile, *The Simpsons* fought back with even more nerdy references, with appearances by the French mathematician Blaise Pascal, numerous jokes about π, a reframing of a classic puzzle by the English polymath Alcuin of York (c735 – 804) and much more.

After spending a week with the writers, it was clear that their fascination with numbers is as strong as ever, and to some extent there was even regret that they had abandoned mathematics in favor of television. In the case of Cohen, his regret at neither proving a deep conjecture nor discovering new geometries is tempered by the feeling that he might have made an indirect contribution to research: "I really would have preferred to live my whole life as a researcher, but I do think that *The Simpsons* and *Futurama* make mathematics and science fun, and perhaps that could influence a new generation of people; so, somebody else down the line might achieve what I didn't achieve. I can certainly console myself and sleep at night with thoughts like that."

GALLERY

FRESHER'S WELCOME



INTERACTIVE SESSION WITH FINAL YEAR STUDENTS

TEACHER’S DAY

COLLOQUIUM YEAR ROUNDUP

Another eventful year comes to an end. We would like to share the year-long experiences of the Colloquium office bearers with the readers. The following is a short account of what all Colloquium did this year.

Freshers' Welcome:

The year started with another fresh group of students joining the Institute, fulfilling the long dream of clearing the JEE. The freshers were given a welcome note from the Colloquium on the registration day itself which included a brief introduction of the Department such as courses offered, achievements, prominent faculties and alumni and of course about the Colloquium and its activities followed by the speech of HOD. Later in August, the Department of Mathematics organized a Freshers' Welcome event to welcome the newcomers in the family. The ceremony started with formal introductions of the freshers, followed by performances which ranged from a group skit, to singing, drawing etc. The night wrapped up on a high-glutton note – a lavish feast wherein freshers involved in a casual interaction with their seniors.

Teachers' day:

Later this academic year, commemorating the birthday of Sarvepalli Radhakrishnan, Teachers' day was celebrated with great vigor and enthusiasm. Quiz was the highlight of the day. Professors and Students teamed up together for one last duel. Puzzles and General Mathematical questions were showered upon them. Finally, the event concluded with presenting the professors with the mementos.

Interactive Session with pre-final and final year Students:

Is it going to be finance for me? What about Data Science? Oh my! How could I possibly forget about Competitive Coding! All the doubts were sort of sorted out when a casual conversation ensued between the 2nd year students and the 4th & 5th year Students.

Xponent:

Of course, we cannot forget the sugar cube you are currently holding in your hands. It took time, for it was worth it.

If you have any suggestions, do not hesitate to mail us at contact.maths@gmail.com. The sugar lumps need more sweetening!

PLACEMENT 2017

13MA20011	Arnav Jain	Microsoft
13MA20014	Ayushya Anand	Sprinklr
13MA20015	Dinesh Kumar meel	Times Internet
13MA20018	Kumar Shivashish	Deutsche Bank
13MA20019	Kunal Singh	Walmart Labs
13MA20020	Kundan Kumar	Standard Chartered Bank
13MA20021	Manish Kumar	Capillary Technologies
13MA20022	Mayank Sikka	Mentor Graphics
13MA20023	Mudit Bachhawat	Amazon India
13MA20024	Narravula Hareesh Kulakarni	JP Morgan Chase & Co.
13MA20025	Neeraj bhukania	American Express
13MA20026	Nishith Shah	Capital one
13MA20027	P. Sai Dheeraj Kumar	Barclays
13MA20031	PRIYANK YADAV	SAP LABS
13MA20032	Priyanka Ranjan	Fidelity Investments
13MA20033	Ravi Kumar Choudhary	Oracle Financial Software Services
13MA20034	Paramesh	VISA
13MA20036	Satyam Kumar Jha	Tesco
13MA20037	Saurav Kumar	Capillary Technologies
13MA20038	Shivam Adarsh	Fidelity Investments
13MA20040	Shubhrit Agrawal	VISA
13MA20041	Siddhartha Tekriwal	Goldman Sachs
13MA20043	Tanumoy Bar	Standard Chartered Bank
13MA20044	Utkarsh Agrawal	Fractal Analytics
13MA20045	Venkanna Banothu	Azista Industries Pvt Ltd.
13MA20048	ADARSH PANDEY	SAMSUNG
13MA20050	Ksheera Sagar Keralapura Nagaraju	EXL
13MA20051	Harshit Khandelwal	Amazon Development Center India
13MA20053	Ayushi Mrigen	Google
13MA20054	Rishabh Miglani	JP Morgan Chase & Co.

GOODBYE KGP!

Yo ! People,

I entered this holy place (for me) with an admission into Dept. of Chemistry. But by the obvious brainwashing by wingees in first year, I changed to Math & Computing, With a unhappy transition, I lost interest in coding (which I had developed in PDS). I was spending time in Algo lab, where I dreamed of spending my time in a chemistry lab. So right from the 3rd semester, I realized that coding is not a piece in my plate. But I really enjoyed each and every math course of the dept. In fact I regret today that I should have pursued them with greater rigor. Slowly I developed a interest in stats, took additional's and finally I am with a PhD offer now. So by my story I want to emphasize that **"if you miss what you had really wanted, try for the next interest - you may land up in something beautiful"**

The other side of my life at KGP is my Hall. Starting from Secretary mess, General Secretary Mess to Second Senate Member - the three years - 2014-17 made me a complete human being and more importantly inculcated a feeling in me to serve the people. The feeling of attachment to hall and a spirit to serve made me so crazy that I took up the responsibility of UG Rep in final year when all placements, PhD apps were at stake. But I was just remembering one line said by my senior **"Logon ka bhala karo, aur khud immandar raho, tumhara tho bhala hona hi hai".** And it all happened as said.

My track may be so glorious to all the readers, but I have failed in one aspect. I haven't earned friends over here. I have people with me to work together. But I have no one of them to hang out, to go on a trip etc. Being in all posts over the last 4 years, you may not believe that I haven't visited flavours for any treat/party etc. So I would like to advise you that **"Being workaholic is great, but please do have your personal space and have a group of guys to hangout/ laugh/ drink/ cry etc."**

So coming to an end, 4 simple advises 1) Work for people and then for yourselves 2) Earn Friends and Make your time over here great 3) Do not indulge in weed and lastly 4) Make the glory of KGP glow in your hearts but not on your fb timelines !

Yo ! KGP :)

-Ksheera Sagar

KGP is a world in itself. Well, we have our own lingo, our own special foods cooked nowhere else and unity amongst the diverse junta in the campus. With a huge campus, never ending opportunities and multiple hangout places, we have our own mini culture to live by. We have our own little ways of celebrating different occasions and festivals and finally never ending tempo for almost everything. It's a home away from home which will always be dear to us. The memories we collect during our stay in KGP are countless and it's almost impossible to capture them all except in our hearts. I made many friends that will last a lifetime, take on many journey that are truely life changing and leaving this place, a completely transformed person! My perspective towards life has changed and I am graduating from here with our bags full of memories and hearts full of love for KGP. I have millions of memories in KGP in many places spread around the campus, tata sports complex, jnan ghosh, tikka, cheddis, departments, gymkhana, 2.2, lakeside and many more. They will stay forever in my heart.

To juniors: KGP has a lot of things to offer from the academic opportunities, competitions to the various societies, cultural, tech and sports events. Try to get most of it, don't confine yourself to your room. Get involved - organizing events, leading teams etc. Not just for CV, anything that you think will help you grow as a person, just go for it. All the best! KGP, it's a once in a lifetime voyage, a journey that I'll never forget. KGP ka tempo high hai!!

-Manish Kumar

FACULTY AT A GLANCE

Prof. Mahendra Prasad Biswal
Research Interest: Operations Research, Computational Statistics & Stochastic Programming, Fuzzy and Convex Optimization, Game Theory and Applications, Analytic Hierarchy Process (AHP), Interior Point Methods (IPM), Multi-Objective Multi-Level & Multi-Choice Programming, Decision Sciences.

Prof. Umesh Chandra Gupta
Research Interest: Statistics, Stochastic modelling, Queueing Theory.

Prof. Vasudeva Rao Allu
Research Interest: Complex Analysis, Univalent Function Theory, Harmonic Mappings (in the Plane).

Prof. Bibhas Adhikari
Research Interest: Applied Linear Algebra, Complex Networks, Quantum Entanglement.

Prof. Somnath Bhattacharyya
Research Interest: Computational Fluid Dynamics, Micro-/nanofluidic Modeling.

Prof. Bappaditya Bhowmik
Research Interest: Geometric function theory (Complex Analysis), Harmonic and Quasiconformal Mappings, Several Complex Variables.

Prof. Debapriya Biswas
Research Interest: Functional Analysis, Lie Groups Lie Algebras and their Representation theory, Complex Analysis, Harmonic Analysis, Hyper-Complex Analysis including Clifford Algebras.

Prof. Debjani Chakraborty
Research Interest: Fuzzy Optimization, Fuzzy logic and its applications.

Prof. Asish Ganguly

Research Interest: Mathematical & Theoretical Physics, Quantum Mechanics, Non-linear Evolution Equation in Real & Complex Domain, Soliton Theory and Inverse Scattering Transformation, Ordinary and partial differential equations.

Prof. Ratna Dutta

Research Interest: Functional Encryption and Attribute Based Cryptosystems, Elliptic Curves and Pairing based Cryptography Oblivious Transfer and Private Set Intersection,

Lattice-Based Cryptography, Multilinear maps and Obfuscation. Secure Multiparty Computation, Broadcast Encryption and Traitor Tracing.

Prof. Rupanwita Gayen

Research Interest: Linear water waves, Integral equations.

Prof. Koeli Ghoshal

Research Interest: Mathematical Modelling of sediment-laden turbulent flow, Grain-size distribution in suspension, Secondary current, Study on different parameters of sediment transport.

Prof. Adrijit Goswami

Research Interest: Operations Research, Data Mining, Cryptography and Network Security.

Prof. Dharmendra Kumar Gupta

Research Interest: Numerical Analysis and Computer Science, Constraint Satisfaction Problems.

Prof. Nitin Gupta

Research Interest: Numerical Analysis Applied Probability, Mathematical Statistics, Reliability Theory and Computer Science, Constraint Satisfaction Problems.

Prof. Swanand Ravindra Khare

Research Interest: Numerical Linear Algebra, Chemometric.

Prof. Pawan Kumar

Research Interest: Graph Theory.

Prof. Somesh Kumar

Research Interest: Statistical Decision Theory, Estimation Theory, Quantum Information and Computation, Statistical Data Analysis, Experimental Designs, Entropy Estimation, Reliability Estimation, Estimation under Constraints, Estimating Parameters of Directional Distributions, Classification under Restrictions, Robust Estimation, Reliability Ordering, Dependent Trials.

Prof. Sourav Mukhopadhyay
Research Interest: Algebraic Cryptanalysis on Symmetric Cipher., Digital rights management, Key pre-distribution for, Wireless Sensor Networks, Time/Memory Tradeoff Cryptanalysis, Cloud Computing.

Prof. Jitendra Kumar
Interest: Particle technology, Numerical mathematics, Monte-Carlo simulations

Prof. P V S N Murthy
Interest: Bio-fluid Mechanics, Convective Heat and Mass Transfer in nanofluid.

Prof. Gnaneshwar Nelakanti
Research Interest: Inverse and ill-posed problems, Spectral approximation of integral operators, Approximate solutions of operator equations.

Prof. Chandal Nahak
Research Interest: Variational and Complementarity problems, Fractional Calculus, Numerical Optimization, Set Valued optimization, Frame Theory in Semi Inner Product Spaces, Applied Functional Analysis and Optimization, Optimization Problems on Manifolds.

Prof. Ramakrishna Nanduri
Research Interest: Commutative Algebra.

Prof. Geetanjali Panda
Research Interest: Portfolio Optimization, Numerical Optimization, Optimization with uncertainty, Convex Optimization.

Prof. Rajnikant Pandey
Research Interest: Differential Equations (Ordinary), Theoretical Numerical Analysis, Singular Boundary Value Problems.

Prof. Raja Sekhar G P
Research Interest: Boundary integral methods for viscous flows, Hydrodynamic and thermocapillary study of viscous drops, Applications of binary mixture theory to biological tissues.

Prof. T. Raja Sekhar

Research Interest: Quasilinear Hyperbolic System of Conservation Laws, Lie Group Analysis for Quasilinear Hyperbolic System of Partial Differential Equations, Symmetry Integration Methods for Differential Equations.

Prof. Parmeshwary Dayal Srivastava

Research Interest: Functional Analysis & Cryptography, Fuzzy Sequence Space.

Prof. Mousumi Mandal

Research Interest: Combinatorial Commutative Algebra and Algebraic Geometry.

Prof. Pratima Panigrahi

Research Interest: Algebraic and Spectral Graph Theory, Irreducible No-hole Colorings, Self-centered Graphs, Existence of Strongly Regular Graphs.

Prof. Rajesh Kannan

Research Interest: Matrix theory, Spectral graph theory and Functional analysis.

Prof. Shirshendu Chowdhury

Partial Differential Equations, Fluid Mechanics, Control Theory: Linear and Nonlinear Partial Differential Equations, Fluid Mechanics, Compressible Navier-Stokes equations, Viscoelastic flow of Maxwell and Jeffrey's fluid, Control of PDE (Controllability, Stabilizability, Optimal control problem for Compressible Navier-Stokes equations and Viscoelastic fluid model).

THE COLLOQUIUM BODY

HAREESH KULAKARNI NARRAVULA
(PRESIDENT)

SHUBHAM PATIDAR
(VICE PRESIDENT)

YAJUVENDRA SINGH
(VICE PRESIDENT)

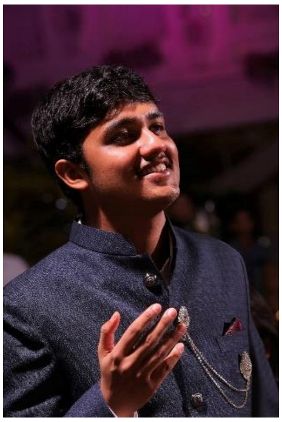
SIDDHARTH JINDAL
(GENERAL SECRETARY)

NUPUR GUNWANT
(GENERAL SECRETARY)

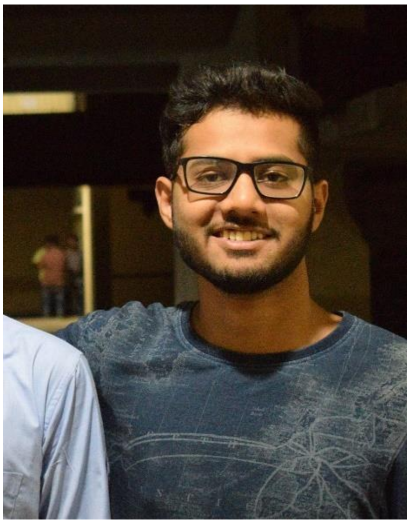
NITIN CHOUDHARY
(WEB SECRETARY)

BHUVNESH BHUVAN
(EDITOR)

PRASANNA KUMAR
(TREASURER)



NAMAN GUPTA
(EVENTS CO-ORDINATOR)



HARSHIT CHOUHAN
(SECRETARY OF ALUMNI AFFAIRS)

2nd YEAR REPRESENTATIVES

LALIT RAO

SANTOSH SATWIK L

RAHUL BAGHEL

KRISHNA KUNAL

HIMANSHU

MAYANK LALWANI

BATCH OF 2018


Dedicated to
service of the


11MA20012
Ayush Agrawal


12MA20035
Rajdeep Sarkar


13MA20002
Abhilash Kumar


13MA20003
Abhinav Agarwalla


13MA20004
Abhinav Jain


13MA20005
Aman Kumar


13MA20006
Aman Thakur

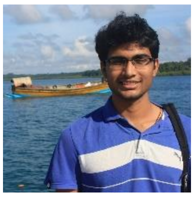

13MA20008
Ankush Chatterjee


13MA20009
Anupam Khattri


13MA20010
Aradhya Kasat


13MA20011
Arnav Jain


13MA20012
Arpan Agarwal


13MA20013
Ayush Bhargava


13MA20014
Ayushya Anand


13MA20015
Dinesh Kumar meel


13MA20016
Harinadh Kunapareddy


13MA20018
Kumar Shivashish


13MA20019
Kunal Singh


13MA20021


16MA20023
Mudit Bachhawat

Manish Kumar


13MA20024
N.Hareesh Kulakarni


13MA20025
Neeraj bhukania


13MA20026
Nishith Kumar Shah


13MA20027
P. Sai Dheeraj Kumar


13MA20028
Piyank Sarawagi


13MA20031
Priyank Yadav

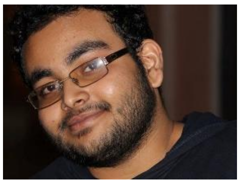

13MA20032
Priyanka Ranjan


13MA20033
Ravi Kumar Choudhary


13MA20034
Paramesh


13MA20036
Satyam Kumar Jha


13MA20037
Saurav Kumar


13MA20038
Shivam Adarsh


13MA20039
Shivam Vats


13MA20040
Shubhrit Agrawal


13MA20041
Siddhartha Tekriwal


13MA20042
Subhajit Kumar Barman


13MA20043
Tanumoy Bar


13MA20044
Utkarsh Agrawal


13MA20045
Venkanna Banothu


13MA20046
Yashpal Singh


13MA20047
Yogesh Kumar Ankur


13MA20048
Adarsh Pandey


13MA20049


13MA20050
Ksheera Sagar K N


13MA20051
Harshit Khandelwal


13MA20052
Mayank Bhargava


13MA20053
Ayushi Mrigen


13MA20054
Rishabh Miglani

Department of Mathematics
IIT Kharagpur