DEPARTMENT OF MATHEMATICS

IIT KHARAGPUR

XPONENT 2016

9th EDITION

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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.U.C.Gupta, and the Professor-in-Charge of the Colloquium, Prof. P.V.S.N.Murthy, 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 you the ninth edition of Xponent. At the very outset, let me take this opportunity to thank and congratulate the whole colloquium team for the publication of the magazine and the commenced academic year 2015-16.

We started off by organizing the Freshers' Introduction which was thoroughly enjoyed by the newly inducted students and the professors alike. This was followed by the Teachers' day celebrations and Saraswati Puja. In addition to regular events, we also organized an interactive session for 2nd, 3rd and 4th years of the undergraduate program to help them prioritize among career available avenues and be more informed about the processes involved. Apart from these events, we ideated a lecture series by in-house faculty to introduce department students to relevant upcoming fields in the industry but were hit by a few roadblocks. I expect the incumbent team to take this idea forward in the next year and make it a reality. I would also plead to the readers of this magazine to bring up and suggest us new ideas pertaining to the betterment of the student-faculty interaction in the department which remains our primary aim.

Looking back on the past few years introspectively gives me a sense of pride and wistfulness to have been a part of this institute and department. Personally and professionally, I grew a lot along various dimensions which should be credited to my batchmates and professors. Last but not the least, I cherish my three years of membership at the Mathematics Colloquium for the wonderful company of seniors, batchmates and juniors alike. As I graduate from the institute in less than a month, I wish the next team great success in all their endeavors.

Signing off,
Aman Aniket
President
The Mathematics Colloquium

EDITORIAL

Welcome to the 9th edition of Xponent. Hope it brings something for every reader interested in mathematics. Over nine years ago, the Mathematics Colloquium started to publish a magazine called Xponent. And here you hold the 9th edition of the same yearly publication. Little had I known that bringing out a magazine demanded so much dedication and time. This magazine, which seemed to be running into a lot of trouble, has finally made it to you, thanks to the long hours put in by all the Colloquium members.

Several changes have been made relative to the previous editions, with an aim to cater to all categories of readers. We also decided to keep humor an important component of the magazine after receiving positive feedback for this from the last edition.

To make it appealing to all sections this year we decided to ponder mostly in popular Mathematics. You will find each and every article very simple yet they point to some integral topic of Mathematics. Puzzles – One of the most important part in a mathematician's life. The first article itself deals with 5 such mind rattling mathematical puzzle. There are 2 biographies of famous mathematician. One of whose film is getting released this year itself starring Dev Patel of Slumdog Millionaire. There is also an article which deals with mathematicians who can perform integral calculus just by thinking without a pen and paper. And then the most important part "Goodbye Kgp" which gives the juniors an insight of what the 5-year life they are spending is going to be like. I on behalf of all the juniors thank the seniors who took out time to share their experiences, the dos and dont's etc. Ok let's stop here and lets not give any more spoiler alerts.

Lastly, I wish the departing batch the very good luck for their future and am confident that they will be successful and make the department and IIT Kharagpur proud. I hope that this magazine will be enough to make them nostalgic when it falls off the dusty attic, years later.

Tanumoy Bar
Editor
The Mathematics Colloquium

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ARTICLES

5 MIND-RATTLING PUZZLES

1) How to beat Roger Federer at Wimbledon?

Suppose in a hypothetical dimension you somehow gain access to temporary magical powers, you are in the final of the Wimbledon tennis championships up against seven-time winner Roger Federer. Your powers cannot last for the whole match and you must therefore, choose the optimum time for them to run out. What is the score that gives you the maximum chance of winning?

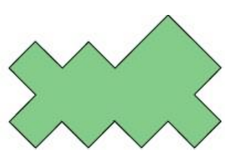
2) Draw one line on this equation to make it correct.

$$5 + 5 + 5 + 5 = 555$$

3) 1,000 school lockers.

There is a school with 1,000 students and 1,000 lockers. On the first day of term the head teacher asks the first student to go along and open every single locker, he asks the second to go to every second locker and close it, the third to go to every third locker and close it if it is open or open it if it is closed, the fourth to go to the fourth locker and so on. The process is completed with the thousandth student. How many lockers are open at the end?

4) Crazy cut



Add one cut (or draw one line), which doesn't need to be straight, that can divide this shape into two identical parts.

5) Coloured socks puzzle.

You are getting dressed in the dark and realize that you forgot to bind all your socks together into pairs. However, you know there are exactly 10 pairs of white socks and 10 pairs of black socks in your draw. All the socks are exactly the same except for their colour. How many socks do you need to take with you to ensure you have at least a pair that match?

-Yajuvendra Singh

THE MAN WHO KNEW INFINITY

Ramanujan was a child prodigy, and a mathematical genius. Despite having no formal outside exposure to advanced mathematics he turned out to be this amazing mathematician which made him one of the most respectable mathematicians in the world. Ramanujan possessed an incredibly amazing intuition for numbers, fractions and infinite series, possibly like no other mathematician ever did. He churned out a huge number of significant and complex results, largely based on 'intuition' mingled with argument and induction, and some sort of innate insight that only he seemed to possess, often without formal proofs and coherent accounts, and at times, without the formal background knowledge of related fields in mathematics that are often used to arrive at such results. He was a self-taught genius from very humble origins, completely disconnected from the world of other excelling mathematicians and largely worked out of his own, in utter isolation (and often in poverty).

Quoting Hardy's observation on Ramanujan - "The limitations of his knowledge were as startling as its profundity. Here was a man who could work out modular equations and theorems... to orders unheard of, whose mastery of continued fractions was... beyond that of any mathematician in the world, who had found for himself the functional equation of the zeta function and the dominant terms of many of the most famous problems in the analytic theory of numbers; and yet he had never heard of a doubly periodic function or of Cauchy's theorem, and had indeed but the vaguest idea of what a function of a complex variable was"

Hardy would compare Ramanujan to the likes of geniuses like Jacobi and Euler, and often mentioned that, he had never met his equal.

As a young man, he failed to get a degree, as he did not clear his fine arts courses, although he always performed exceptionally well in mathematics. His peers rarely understood him at school and was always in awe of his mathematical acumen. Ramanujan had mastered a book on trigonometry at the age of 13 and produced pretty sophisticated results right then. He finished his mathematics exams in half the time, and at graduation was even awarded more than the maximum possible marks, as a recognition for his exceptional performance. He had independently developed and investigated Bernoulli numbers in great detail, and had also derived the Euler's constant all at a very young age, in utter isolation from the rest of the world. Ramanujan had an untimely death at a young age of 32, but by then, he had developed an unparalleled intuition for continued fractions and series, like no other known mathematician. He left behind a 'notebook' with merely summaries and results in it, with little or no proofs - his personal notebook. It seemed that, poor Ramanujan, often used to derive his results on a 'slate' (due to lack of paper), and just jot down his result. He had often derived existing classic results and at times, his own. This notebook later inspired a lot of work, in attempts to prove some of the results, and also led to fields such as 'highly composite numbers'. Ramanujan suggested a huge plethora of formulae based on sheer intuition, that could all then be investigated in depth later. It is said that Ramanujan's discoveries are unusually rich and that there is often more to them than initially meets the eye.

A very shy, quiet and deeply religious man, with pleasant manners, his talent was recognized in stages, by mathematicians in India first, and later by Hardy in Cambridge, was simply astounded when he came across the many fascinating and complex results that this hitherto unknown young man out of nowhere had churned out by sheer intuition.

There is only one thing I'd say, as I end this:

$$\frac{1}{\pi} = \frac{2\sqrt{2}}{9801}\sum_{k=0}^{\infty}\frac{(4k)!(1103+26390k)}{(k!)^4 396^{4k}}.$$

…

-Yajuvendra Singh

Psssssst - “Do not miss this movie releasing 29th April 5, 2016.”

- ;) The Editor

THE GREAT DEBATE

Ask yourself a question – what will we get if we add together all the natural numbers? The answer would be something large beyond our imagination, what we call infinity! Well, that makes sense, isn't it?

But one can come across a simple but not rather obvious proof that the answer to the above question comes out to be astounding -1/12 i.e.

The proof goes as such:

Consider three infinite sums,

S1 = 1-1+1-1+1-1+1- …

S2 = 1-2+3-4+5-6+ …

S = 1+2+3+4+5+6+ …

While evaluating S1 if we stop ourselves at even point, we get 1 and at odd point we get 0, so we can say that the answer is average of the two i.e. ½ (again a matter of debate!)

We can see that S1 = 1 – (1-1+1-1+1-….) = 1 – S1 => S1 = ½

Now,

S2 = 1 – 2 + 3 – 4 + 5 – 6 + ...

=> S2 = 1 – 2 + 3 – 4 + 5 - ...

=> 2S2 = 1 – 1 + 1 – 1 + 1 - ... => S2 = 1/4

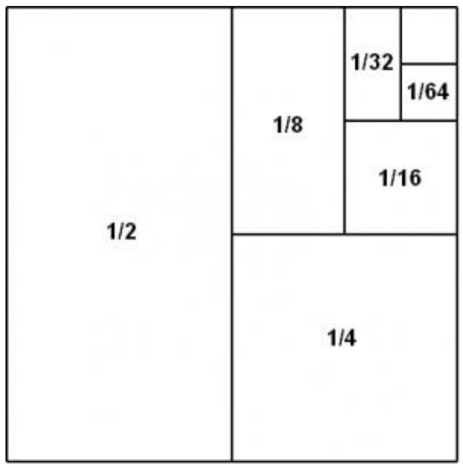
Now, S – S2 = (1 + 2 + 3 + 4 + 5 + 6 + ...) -(1 – 2 + 3 – 4 + 5 – 6 + ...)

∴S – S2 = 4 + 8 + 12 + 16 + 20 + ... = 4 (1 + 2 + 3 + 4 + 5 + ...) = 4 S

∴S = -S2/3 = -1/12

The result finds its applications in various areas of physics including string theory.

This is a meaningful way to associate the number -1/12 to the sum, one may argue that it is misleading to call it as sum of the series. Furthermore, the way it is presented contributes to a misconception that mathematicians are arbitrarily changing the rules for no apparent reason, and students have no hope of knowing what is and isn't allowed in a given situation. A depressingly large portion of the population automatically assumes that mathematics is some non-intuitive, bizarre wizardry that only the super-intelligent can possibly fathom. Showing such a crazy result without qualification only reinforces that view. Addition is a binary operation. You put in two numbers, and you get out one number. But you can extend it to more numbers. If you have, for example, three numbers you want to add together, you can add any two of them first and then add the third one to the resulting sum. We can keep doing this for any finite number of addends (and the laws of arithmetic say that we will get the same answer no matter what order we add them in), but when we try to add an infinite number of terms together, we have to make a choice about what addition means. The most common way to deal with infinite addition is by using the concept of a limit. Roughly speaking, we say that the sum of an infinite series is a number L if, as we add more and more terms, we get closer and closer to the number L. If L is finite, we call the series convergent.



Zeno's paradox says that we'll never actually get to 1, but from a limit point of view, we can get as close as we want. That is the definition of "sum" that mathematicians usually mean when they talk about infinite series, and it basically agrees with our intuitive definition of the words "sum" and "equal." But not every series is convergent in this sense (we call non-convergent series divergent). Some, like 1-1+1-1…, might bounce around between different values as we keep adding more terms, and some, like 1+2+3+4... might get arbitrarily large. It's pretty clear, then, that using the limit definition of convergence for a series, the sum 1+2+3… does not converge. If I said, "I think the limit of this series is some finite number L," I could easily figure out how many terms to add to get as far above the number Las I wanted. There are meaningful ways to associate the number -1/12 to the series 1+2+3…, but I prefer not to call -1/12 the "sum" of the positive integers. One way to tackle the problem is with the idea of analytic continuation in complex analysis. Let's say you have a function f(z) that is defined somewhere in the complex plane. We'll call the domain where the function is defined U. You might figure out a way to construct another function F(z) that is defined in a larger region such that f(z)=F(z) whenever z is in U. So the new function F(z) agrees with the original function f(z) everywhere f(z) is defined, and it's defined at some points outside the domain of f(z). The function F(z) is called the analytic continuation of f(z). ("The" is the appropriate article to use because the analytic continuation of a function is unique.) Analytic continuation is useful because complex functions are often defined as infinite series involving the variable z. However, most infinite series only converge for some values of z, and it would be nice if we could get functions to be defined in more places. The analytic continuation of a function can define values for a function outside of the area where its infinite series definition converges. We can say 1+2+3...=-1/12 by retrofitting the analytic continuation of a function to its original infinite series definition, a move that should come with a Lucille Bluth-style wink. The function in question is the Riemann zeta function, which is famous for its deep connections to questions about the distribution of prime numbers. When the real part of s is greater than 1, the Riemann zeta function ζ(s) is defined to be Σ∞n=1 n-s. (We usually use the letter z for the variable in a complex function. In this case, we use s in deference to Riemann, who defined the zeta function in an 1859 paper). This infinite series doesn't converge when s=-1, but you can see that when we put in s = -1, we get 1+2+3…. The Riemann zeta function is the analytic continuation of this function to the whole complex plane minus the point s=1. When s=-1, ζ(s)=-1/12. By sticking an equals sign between ζ (-1) and the formal infinite series that defines the function in some other parts of the complex plane, we get the statement that 1+2+3...=-1/12.

- Shubham Patidar

MATHEMATICIANS WITH EXTRAORDINARY MEMORY

John Wallis (Born: 23 Nov 1616 in Ashford, Kent, England Died: 28 Oct 1703 in Oxford, England) whose calculating powers are described:

Wallis occupied himself in finding (mentally) the integral part of the square root of $3x10^{40}$; and several hours afterwards wrote down the result from memory. This fact having attracted notice, two months later he was challenged to extract the square root of a number of 53 digits; this he performed mentally, and a month later he dictated the answer that he had not meantime committed to writing.

Von Neumann (Born: 28 Dec 1903 in Budapest, Hungary - Died: 8 Feb 1957 in Washington D.C., USA) whose feats of memory are described by Herman Goldstein:

As far as I could tell, von Neumann *was able on once reading a book or article to quote it back verbatim; moreover, he could do it years later without hesitation. He could also translate it at no diminution in speed from its original language into English. On one occasion I tested his ability by asking him to tell me how the 'Tale of Two Cities' started. Whereupon, without pause, he immediately began to recite the first chapter and continued until asked to stop after about ten or fifteen minutes.*

A C Aitken, (Born: 1 April 1895 in Dunedin, New Zealand Died: 3 Nov 1967 in Edinburgh, Scotland).

He could instantly give the product of two numbers each of four digits but hesitated if both numbers exceeded 10,000*. Among questions asked him at this time were to raise* 8 *to the* 16*th power; in a few seconds he gave the answer* 281,474,976,710,656 *which is correct. ... he worked less quickly when asked to raise numbers of two digits like* 37 *or* 59 *to high powers. ...*

Asked for the factors of 247,483 *he replied* 941 *and* 263*; asked for the factors of* 171,395 *he gave* 5, 7, 59 *and* 83*, asked for the factors of* 36,083 *he said there were none. He, however, found it difficult to answer questions about numbers higher than* 1,000,000.

Another mathematician **George Parker Bidder** was born in 1806 at Moreton Hampstead in Devonshire, England. He was not one to lose his skills when educated and wrote an interesting account of his powers in calculating. Again it is worth noting that other members of his family had exceptional powers of memory and calculating.

One of his brothers knew the Bible by heart, another brother, who was an actuary, had the misfortune of having all his books destroyed in a fire. This was not the problem it might have been to an ordinary person since he was able, in the period of six months, to rewrite them from memory. One of Bidder's sons was able to multiply two numbers of 15 digits but he was slow, and less accurate, compared with his father.

- Shubham Patidar

THE MAGIC OF MATHS

Before he ever took a formal algebra class, Arthur Benjamin got a lesson he never forgot. The future mathematician's father said, “Son, doing algebra is just like arithmetic, except you substitute letters for numbers. For example, 2x + 3x = 5x and 3y + 6y = 9y. You got it?” The young Arthur replied that he grasped the concept. After which his dad said, “Okay, then what is 5Q + 5Q?”

Arthur replied “10Q.” And his father said, “You're welcome!”

That terrible, wonderful gag appears early in Benjamin's new book, The Magic of Math: Solving for x and Figuring Out Why.

The occasional stabs at humor in Benjamin's book will leave the reader figuratively bloodied but unbowed and buoyed in the brainpan. Whether it's been decades since you last took algebra or you're currently dealing with the aches of solving for x, The Magic of Math is a good read. Even though it includes, gasp, equations. For example, (and don't bother to try to stop me if you've heard this one), consider a pizza pie to be a very short cylinder. The volume of a cylinder equals pi times the radius squared times the height. That is, $V = \pi r^2 h$. And so, deep breath, for a pizza of radius z and height a, V = pi z z a. And if you think that exercise was too cheesy, you need a thicker crust. One of my favorite parts of the book considers a rope tied to the bottoms of the two goalposts on opposite ends of an American football field, 120 yards away from each other. That's 100 yards’ plus the two 10-yard butt slapping and dance areas—I mean the end zones. The taut rope is thus 360 feet long as it traverses the grass along the centerline of the field. Now imagine that the rope gains a measly little foot, so that it's now 361 feet long. At the 50-yard line, how high could you lift the rope, while leaving its ends on the ground at the goalposts?

By lifting the rope, you create an imaginary triangle with a base of 360 feet, an as yet unknown height of h feet, and two sides of 180.5 feet, half of the 361-foot-long rope. Now drop an imaginary plumb line from the top of the rope, and the big triangle can be divided into two smaller and equal right triangles, each with a hypotenuse of 180.5 feet and sides of 180 feet and h feet. Perform the primordial Pythagorean prestidigitation (the sum of the squares of the two sides of a right triangle equals the square of the hypotenuse), and you'll find that the one-foot-longer rope can be lifted high enough for even the most gigantic lineman to trundle under, more than 13 feet off the ground.

I'm fond of this example because the result just felt wrong to me. How could a single additional foot of slack have such a large effect? And yet the math is indisputable, as math tends to be. The Magic of Math thus reminds the reader that reality cares not how you feel about it. Which is why I recommending the book to anyone involved in making public policy. No amount of additional analysis, fact finding commissions, committee hearings or white papers will change the height of that rope. 10Q. 10Q very much.

- Vinay Chandil

MATH: DISCOVERED, INVENTED OR BOTH?

Mathematics is the language of science and has enabled mankind to make extraordinary technological advances. There is no question that the logic and order that underpins mathematics, has served us in describing the patterns and structure we find in nature. The successes that have been achieved, from the mathematics of the cosmos down to electronic devices at the microscale, are significant. Einstein remarked, "How can it be that mathematics, being after all a product of human thought which is independent of experience, is so admirably appropriate to the objects of reality?"

How is it possible that all the phenomena observed in classical electricity and magnetism can be explained by means of just four mathematical equations? Moreover, physicist James Clerk Maxwell (after whom those four equations of electromagnetism are named) showed in 1864 that the equations predicted that varying electric or magnetic fields should generate certain propagating waves. These waves—the familiar electromagnetic waves (which include light, radio waves, x-rays, etc.)—were eventually detected by the German physicist Heinrich Hertz in a series of experiments conducted in the late 1880s.

And if that is not enough, the modern mathematical theory which describes how light and matter interact, known as quantum electrodynamics (QED), is even more astonishing. In 2010 a group of physicists at Harvard University determined the magnetic moment of the electron (which measures how strongly the electron interacts with a magnetic field) to a precision of less than one part in a trillion. Calculations of the electron's magnetic moment based on QED reached about the same precision and the two results agree! What is it that gives mathematics such incredible power? The puzzle of the power of mathematics is in fact even more complex than the above examples from electromagnetism might suggest. There are actually two facets to the "unreasonable effectiveness," one that I call active and another that I dub passive. The active facet refers to the fact that when scientists attempt to light their way through the labyrinth of natural phenomena, they use mathematics as their torch. In other words, at least some of the laws of nature are formulated in directly applicable mathematical terms. The mathematical entities, relations, and equations used in those laws were developed for a specific application. Newton, for instance, formulated the branch of mathematics known as calculus because he needed this tool for capturing motion and change, breaking them up into tiny frame by frame sequences. Similarly, string theorists today often develop the mathematical machinery they need. At the core of this math mystery lies another argument that mathematicians, philosophers, and, most recently, cognitive scientists have had for a long time: Is math an invention of the human brain? Or does math exist in some abstract world, with humans merely discovering its truths? The debate about this question continues to rage today.

Personally, I believe that by asking simply whether mathematics is discovered or invented, we forget the possibility that mathematics is an intricate combination of inventions and discoveries. Indeed, I posit that humans invent the mathematical concepts—numbers, shapes, sets, lines, and so on—by abstracting them from the world around them. They then go on to discover the complex connections among the concepts that they had invented; these are the so called theorems of mathematics.

I must admit that I do not know the full, compelling answer to the question of what is it that gives mathematics its stupendous powers. That remains a mystery.

- Vinay Chandil

MATHEMATICS IN DAILY LIFE

When you buy a car, follow a recipe, or decorate your home, you're using math principles. People have been using these same principles for thousands of years, across countries and continents. Whether you're sailing a boat off the coast of Japan or building a house in Peru, you're using math to get things done.

How can math be so universal? First, human beings didn't invent math concepts; we discovered them. Also, the language of math is numbers, not English or German or Russian. If we are well versed in this language of numbers, it can help us make important decisions and perform everyday tasks. Math can help us to shop wisely, buy the right insurance, remodel a home within a budget, understand population growth, or even bet on the horse with the best chance of winning the race.

When you buy a car, follow a recipe, or decorate your home, you're using math principles. People have been using these same principles for thousands of years, across countries and continents. Whether you're sailing a boat off the coast of Japan or building a house in Peru, you're using math to get things done. How can math be so universal? First, human beings didn't invent math concepts; we discovered them. Also, the language of math is numbers, not English or German or Russian. If we are well versed in this language of numbers, it can help us make important decisions and perform everyday tasks. Math can help us to shop wisely, buy the right insurance, remodel a home within a budget, understand population growth, or even bet on the horse with the best chance of winning the race.

Each year, millions of people travel to casinos hoping they will come away richer. Many more people visit their local supermarket each day to bet with lottery cards. People play the stock market, join in the office football pool, and meet with friends on the weekend for a game of poker. Why do we invest this money on chance? We do it because we believe we can beat the odds. We believe in the possibility of winning.

Mathematical principles can tell us more than whether it is possible to win. They can tell us how often we are likely to win. The mathematical concept that deals with the chances of winning a lottery drawing or a poker game is probability. If we can determine the probability that a certain event (such as winning the lottery) will occur, we can make a better choice about whether to risk the odds.

How do we determine probability? Let's say there are 12 socks in your dresser drawer. Five are red and 7 are blue. If you were to close your eyes, reach into the drawer, and draw out 1 sock, what is the probability that it would be a red sock? Five of the 12 socks are red, so your chances of picking a red sock are 5 out of 12. You can set this up as a fraction or a percentage that expresses the probability of picking a red sock: 5/12 Your chances of picking a red sock are 5 out of 12, or 5 divided by 12, which is about 42%. Not bad, as odds go. Imagine you're choosing between 2 colleges, 1 in California and 1 in Massachusetts. You decide to flip a coin. Heads, you'll go to California. Tails, you'll go to Massachusetts. When you toss the coin, what is the probability that the head side of the coin will be facing up once the coin hits the floor? There are 2 sides to a coin, and 1 of them is heads, so your odds are 1 out of 2. In other words: 1/2 One divided by 2: that's a 50% chance of heads, and therefore also a 50% chance of tails. The odds are equal. You're as likely to go to California as to Massachusetts if you base your decision on a coin toss. Even if you don't frequent casinos, you probably play the odds all the time. You might invest in the stock market. You might buy auto, health, and life insurance as a hedge against the costs of damage or injury. In many cases in which you are trying to predict the future, you're using the mathematics of probability.

Place Your Bets: Cashing in on Probability Thinking about going to a casino to play roulette and win a bundle? There's something you should know before you ante up. It's much more likely that the casino will win than you will. The roulette wheel is divided into 38 numbered slots. Two of these slots are green, 18 are red, and 18 are black. To begin the round, the wheel is spun and a ball is dropped onto its outside edge. When the wheel stops, the ball drops into 1 of the 38 slots. Players bet on which slot they believe the ball will land in. If you bet your money that the ball will land in any of the 18 red slots, your chances of winning are 18 out of 38. If you bet your money on a certain number, such as the red slot numbered with a 10, your chances of winning drop to 1 in 38. Playing the odds Both you and the people who own the casino are gambling—playing the odds—but the odds that the casino owner will win are much greater than the odds that you will win. In fact, the mathematics of probability guarantee that the owners of the roulette wheel will make money with that wheel, even if they don't win every time. This is no accident of fate. It's the way the game is constructed. Remember those colored slots? There are 18 each of the red and black slots. There are also 2 green slots. Whenever the ball lands in 1 of those green slots, the house wins everything that was bet on that round. So again, let's say you bet that the ball will land in a red slot (or, for that matter, a black slot). This is the safest possible bet in roulette, since the chances are 18 out of 38 that you'll win. But they're 20 out of 38 that you'll lose. If you spend day after day at the roulette table, you will consistently lose over time. But for any given night, the outcome of your bets is much less predictable. You might beat the odds and take home a pocketful of cash, or you might lose fistfuls of money. The casino is not taking any chances, though. The odds make it certain that, over time, the casino will consistently turn a profit.

- Sumit Tiwari

COOKING BY NUMBERS

Not all people are chefs, but we are all eaters. Most of us need to learn how to follow a recipe at some point. To create dishes with good flavor, consistency, and texture, the various ingredients must have a kind of relationship to one another. For instance, to make cookies that both look and taste like cookies, you need to make sure you use the right amount of each ingredient. Add too much flour and your cookies will be solid as rocks. Add too much salt and they'll taste terrible.

That ingredients have relationships to each other in a recipe is an important concept in cooking. It's also an important math concept. In math, this relationship between 2 quantities is called a ratio. If a recipe calls for 1 egg and 2 cups of flour, the relationship of eggs to cups of flour is 1 to 2. In mathematical language, that relationship can be written in two ways: ½ or 1:2. Both of these express the ratio of eggs to cups of flour: 1 to 2. If you mistakenly alter that ratio, the results may not be edible.

All recipes are written to serve a certain number of people or yield a certain amount of food. You might come across a cookie recipe that makes 2 dozen cookies, for example. What if you only want 1 dozen cookies? What if you want 4 dozen cookies? Understanding how to increase or decrease the yield without spoiling the ratio of ingredients is a valuable skill for any cook. Let’s say you have a mouth-watering cookie recipe:

1 cup flour

1/2 tsp. baking soda

1/2 tsp. salt

1/2 cup butter

1/3 cup brown sugar

1/3 cup sugar

1 egg

1/2 tsp. vanilla

1 cup chocolate chips

This recipe will yield 3 dozen cookies. If you want to make 9 dozen cookies, you'll have to increase the amount of each ingredient listed in the recipe. You'll also need to make sure that the relationship between the ingredients stays the same. To do this, you'll need to understand proportion. A proportion exists when you have 2 equal ratios, such as 2:4 and 4:8. Two unequal ratios, such as 3:16 and 1:3, don't result in a proportion. The ratios must be equal. Going back to the cookie recipe, how will you calculate how much more of each ingredient you'll need if you want to make 9 dozen cookies instead of 3 dozen? How many cups of flour will you need? How many eggs? You'll need to set up a proportion to make sure you get the ratios right. Start by figuring out how much flour you will need if you want to make 9 dozen cookies. When you're done, you can calculate the other ingredients. You would read this proportion as "1 cup of flour is to 3 dozen as X cups of flour is to 9 dozen." To figure out what X is (or how many cups of flour you'll need in the new recipe), you'll multiply the numbers like this:

X times 3 = 1 times 9

3X = 9

Now all you have to do is find out the value of X. To do that, divide both sides of the equation by 3. The result is X = 3. To extend the recipe to make 9 dozen cookies, you will need 3 cups of flour. What if you had to make 12 dozen cookies? Four dozen? Seven-and-a-half dozen? You'd set up the proportion just as you did above, regardless of how much you wanted to increase the recipe.

Meters and Liters: Converting to the Metric System of Measurements

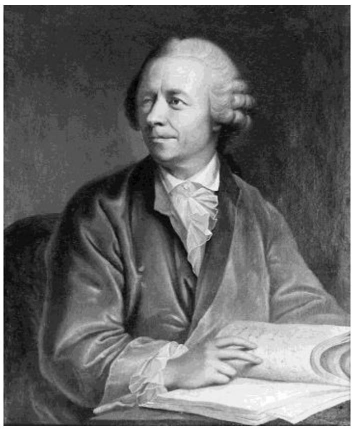
Most of the world uses a standard system of measurements called the metric system. This system is based on a unit of measurement called the meter, which gets its name from the Greek word metron, "a measure." One meter is equal to 1 ten-millionth of the distance from the equator to the North Pole. It's a standard for measuring length that is derived from the planet we live on. The metric system has been around for 300 years. France was instrumental in its creation and in 1795 was the first country to adopt it (though in the early 1800s, the emperor Napoleon briefly set it aside in favor of the old system of measurement). The United States remains one of the few countries that has not yet adopted the metric system as the standard for measurement.

Making the transition to metric measures

Although Thomas Jefferson and John Quincy Adams once promoted its ease and efficiency, the metric system has been slow to gain a hold in the U.S. That may change, however. The U.S. government still hopes to gain acceptance of the metric system gradually by enlisting the support of business and industry. Most businesses that sell products abroad use metric measurements, sometimes in addition to inches or ounces. In 1994, Congress passed a law requiring that packaging for consumer products include both traditional and metric measurements.

- Sumit Tiwari

LEONHARD EULER



Leonhard Euler was one of the greatest mathematicians of all time. His numerous works (over 900 publications) in many areas had a decisive influence on the development of mathematics, an influence that is felt to this day. Euler was born in Switzerland, in the town of Basel, on the 15th of April 1707, in the family of a pastor. At that time, Basel was one of the main centers of mathematics in Europe.

At the age of 7, Euler started school while his father hired a private mathematics tutor for him. At 13, Euler was already attending lectures at the local university, and in 1723 gained his masters degree, with a dissertation comparing the natural philosophy systems of Newton and Descartes. On his father's wishes, Euler furthered his education by enrolling in the theological faculty, but devoted all his spare time to studying mathematics. He wrote two articles on reverse trajectory which were highly valued by his teacher Bernoulli.

In 1727 Euler applied for a position as physics professor at Basel university, but was turned down. At this time a new center of science had appeared in Europe - the Petersburg Academy of Sciences. As Russia had few scientists of its own, many foreigners were invited to work at this center - among them Euler. On the 24th of May 1727 Euler arrived in Petersburg. His great talents were soon recognized. Among the areas he worked in include his theory of the production of the human voice, the theory of sound and music, the mechanics of vision, and his work on telescopic and microscopic perception. On the basis of this last work, not published until 1779, the construction of telescopes and microscopes was made possible. In his study of colour effects, Euler hoped to make use of the observation of the conjunction of Venus and the moon, due to take place on the 8th of September 1729. However, no such effects were observed during this conjunction, and Euler was forced to wait for the eclipse of the sun which would take place in 1748.

He observed this eclipse in Berlin, where he moved in 1741. Here he worked in the Berlin Academy of Sciences and was appointed as head of the Berlin Observatory, and was also tutor to the nieces of King Frederich II of Prussia. Observations of the eclipse of the sun made by scientists of the day led them to believe that the moon did not contain sufficient atmosphere to provide the effects of diffraction or refraction. Only Euler was able to detect the moon's atmosphere. And in 1761, when Venus passed over the face of the sun, he detected the atmosphere of Venus.

Euler's works were not devoted solely to the natural sciences. A true renaissance man, he also involved himself in the philosophical debates of the day, and triumphantly declared himself a firm believer in the freedom of the will. Such views won him few friends in Germany, and the book in which he thus expressed himself was published for the first time in Russia, where Euler returned in 1766. Here he found many who agreed with his views, among them enemies of the views of Leibnitz and Voltaire. In 1763 Catherine II came to the throne. She carried out reforms in the Academy of Sciences and aimed to make it a more prestigious institution. When Euler returned to Petersburg with his two elder sons they were given a two storey house on the banks of the Neva and Euler given a position at the head of the Academy of Sciences. At the time of his return to Petersburg Euler had already reconsidered his views on the atmosphere of planets.

The work of Lomonosov and Bernoulli in this field led him to conclude that the atmosphere on the Earth and on other planets must be considerably more transparent than he had thought. Euler took a very active role in the observation of the movement of Venus across the face of the sun, despite the fact that at this time he was nearly blind. He had already lost one eye in the course of an experiment on light diffraction in 1738, and an eye disease and botched operation in 1771 led to an almost total loss of vision. This did not, however, stop Euler's creative output. Until his death in 1783, the Academy was presented with over 500 of his works. The Academy continued to publish them for another half century after the death of the great scientist. To this day, his theories are studied and taught, and his incredibly diverse works make him one of the founding fathers of modern science.

- Sumit Tiwari

GALLERY

Fresher’s Welcome

Teacher's day celebration

GOODBYE KGP

The past 5 years have been amazing for me. Thanks to the Department and the Institute for making this journey thrilling and joyful. General Championships, Exams, Illumination, Rangoli, Classes, Internship, Placement and many more things whose experiences I have shared with my best friends, I am going to miss them all. I will always have a bundle of good memories from KGP which I am going to cherish for my entire life. I would suggest juniors to explore themselves and explore the many opportunities the campus is filled with. Find your passion or build it and keep learning new stuffs. Make friends as they are the ones that will matter the most in your years in KGP. Enjoy and party the many special moments which you are going to have here. And always try to maintain a good academic record.

- Aman Kumar Jaiswal

It has been an overall awesome experience. From DAA to Topology, we have seen everything. Taking about suggestions for juniors, I would list down do's & don't as follows: -

1. Please attend classes at least 70%. Especially if your CG is low.
2. CG matters above all. So, don't compromise your CG for anything.
3. At the same time, don't confine yourself only to acads. There is so much to explore, from poltu to general championship, from shergil to tikka.
4. Once in a while smoking is OK. But, if smoking is overpowering you, then you need to give a serious thought about this. My suggestion would be to avoid these things as much as you can. There is no studapa in having G and suffering from headache for two-three days.
5. Use your vacation properly. Don't do anything just for CV. In a long run, your experiences matter, not the headlines.

So, Best of Luck Guys. KGP KA TEMPO HIGH HAI. – Abhishek Kumar

Firstly, enjoy your stay at kgp by you know hanging out at night ;), participating in extra-academic activities like Sports, Socult activities and remember, whatever you do, reach the maximum heights on it. Like be a part of inter IIT or interhall team. Do not have what you say "fear of failure", instead "dare to fail". If you don't get what you want, then you deserve more than that. Remember the line "Experience is what you get when you don’t get what you wanted." If you are looking for internships in your 2nd or 3rd year, first take all fundas from senior as they already have been where you are right now, in fact stay in contact with them as they know more about department. You can also make your personal website/portfolio and make LinkedIn profile. All the Best! - Ayush Shukla

COLLOQUIUM YEAR ROUNDUP

Another eventful fun filled year comes to an end. As we look behind we see the responsibilities we took as a member of the colloquium. The events that took place, the ideas we as a group put forward to hold the integrity of the students with the teachers. While we encountered a few huddles on our path, we still succeeded in ending the year on a high note. 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 to welcome the newcomers in the family. The ceremony started with formal introductions of the freshers by themselves followed by some cool performances which ranged from a group skit, to singing, drawing etc. The night wrapped up on the usual 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 a fun filled event. Where both the professors and students teamed up together into 2 groups competing against each other to win the most coveted trophy of the Quiz competition. It mostly consisted of puzzles and Mathematics General Knowledge questions. The quiz was hosted by Tanumoy Bar, which was really a success as the Professors enjoyed it a lot. At the last, the event concluded with presenting the professors with the mementos.

Saraswati Puja:

The students, along with the Professors and their families, offered prayers to the Goddess and sought never-ending knowledge and learning.

Xponent:

Of course, we cannot forget the magazine you are currently holding in your hands. This copy is the product of a month of work from the Editorial Team by contributions from alumni and students alike. Several students have spent a lot of time and effort writing thoughtful, insightful articles that would hopefully open new doors for the reader. We earnestly hope that this edition of Xponent is found satisfactory and received as warmly as our prior editions.

If you have any suggestions, do not hesitate to mail us at *contact.maths@gmail.com*

Farewell:

To conclude the year-long activities, the Colloquium manages yet another event, and an indispensable one that is the Farewell. We bid adieu to the final year students and wish them luck in their future endeavors.

PLACEMENT 2016

Roll No.	Name	Placed at
11MA20001	Abhijeet Raj	GOLDMAN SACHS
11MA20002	Abhishek Gautam	PROBE EQUITY RESEARCH
11MA20003	Abhishek Kumar	STAYZILLA
11MA20004	Abhyu Adityan	PERSISTENT SYSTEMS
11MA20005	Aggidi Vineel Raja	INTUIT
11MA20006	Akanksha Chauhan	ACCENTURE
11MA20007	Aman Aniket	INTUIT
11MA20009	Anirban Bhowmik	WORKS APPLICATION
11MA20010	Ankur Singh	WORKS APPLICATION
11MA20011	Ashish Yadav	FIDELITY INVESTMENTS
11MA20014	Ayush Shukla	GOLDMAN SACHS
11MA20017	Bihani Pradeep Gaurishankar	INTUIT
11MA20018	Dalai Bhargav Jnanadev	CIGITAL
11MA20019	Darla Sahul	BABAJOBS
11MA20020	Devbrat Arya	OLA CABS SDE
11MA20021	Disha Sarawgi	DEUTSCHE BANK
11MA20022	Dudhe Harshita Rajendra	ACCENTURE
11MA20023	Mounika Gudla	AFFINE ANALYTICS
11MA20025	Jayanta Kumar Mondal	COGNIZANT
11MA20028	Maneesh Bhunwal	INTUIT
11MA20030	Md Nehal Amin	HT MEDIA LTD.
11MA20031	Md. Wasim Reza Mallick	HOPSCOTCH
11MA20034	Poorvi Agarwal	XEROX RESEARCH CENTRE INDIA
11MA20036	Rahul Raj	INSHORTS
11MA20037	Rishav Raj	MICROSOFT IDC
11MA20038	Rohan Raja	MICROSOFT IDC
11MA20039	Runku Venkata Sasidhar	INNOPLEXUS
11MA20040	Sanat Kumar Panda	FICO
11MA20041	Shefali Yadav	FIDELITY INVESTMENTS
11MA20042	Shiwangi Shah	AMAZON
11MA20043	Shwentanshu Gupta	AMERICAN EXPRESS
11MA20044	Sneha Yadav	EMC CORPORATION
11MA20048	Yogesh Poddar	GOLDMAN SACHS
11MA20050	Anurag Das	HDFC DEVELOPERS LTD.
11MA20051	Neha	XEROX RESEARCH CENTRE INDIA
11MA20052	Ankesh Anand	VISA
11MA20053	Sanjay Sinha	GOLDMAN SACHS

11MA20054	Nimodia Palash Satish	AXTRIA
11MA20055	Sanjeev Tiwari	ACCENTURE
11MA20056	Utkarsh Bajpai	SAMSUNG RESEARCH INSTITUTE BANGALORE
11MA20057	Utkarsh Ray	SAMSUNG RESEARCH INSTITUTE BANGALORE
11MA20008	Aman Kumar Jaiswal	SAMSUNG RESEARCH INSTITUTE BANGALORE
14MA60R12	Ragunath D	GOLDMAN SACHS
14MA60R09	Abhinav Borkar	CISCO
14MA60R01	Salwa Ali Khan	NETAPP

FACULTY AT A GLANCE

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-/nanofluidics Modeling.

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

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. 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. Vinay Kumar Jain
Research Interest: Zeros of polynomials and analytic functions & Extremal problems of polynomials.

Prof. Swanand Ravindra Khare
Research Interest: Numerical Linear Algebra, Chemometrics.

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

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 Trade-off Cryptanalysis, Cloud Computing.

Prof. P V S N Murthy
Research 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. Bhawani Sankar Panda
Research Interest: Algorithmic Graph Theory, Graph Theory, Combinatorial Optimization, Algorithms.

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.

THE COLLOQUIUM BODY

Aman Aniket (President)

Sourav Kumar
(Vice President)

Sushmita Pandula
(Vice President)

Tanumoy Bar
(Editor)

Manish Kumar
(Events Head)

Paramesh Sanjeevi
(Web Head)

Hareesh Kulakarni
(Treasurer)

Sai Dheeraj
(Alumni Head)

SECOND YEAR REPRESENTATIVES –

1. Sumit Sonagra
2. Vinay Chandil
3. Shubham Patidar
4. Yajuvendra Singh
5. Sumit Tiwari
6. Hemachandra Kollisetty

JOURNEY TO A NEW LIFE

DEPARTMENT OF MATHEMATICS

IIT KHARAGPUR