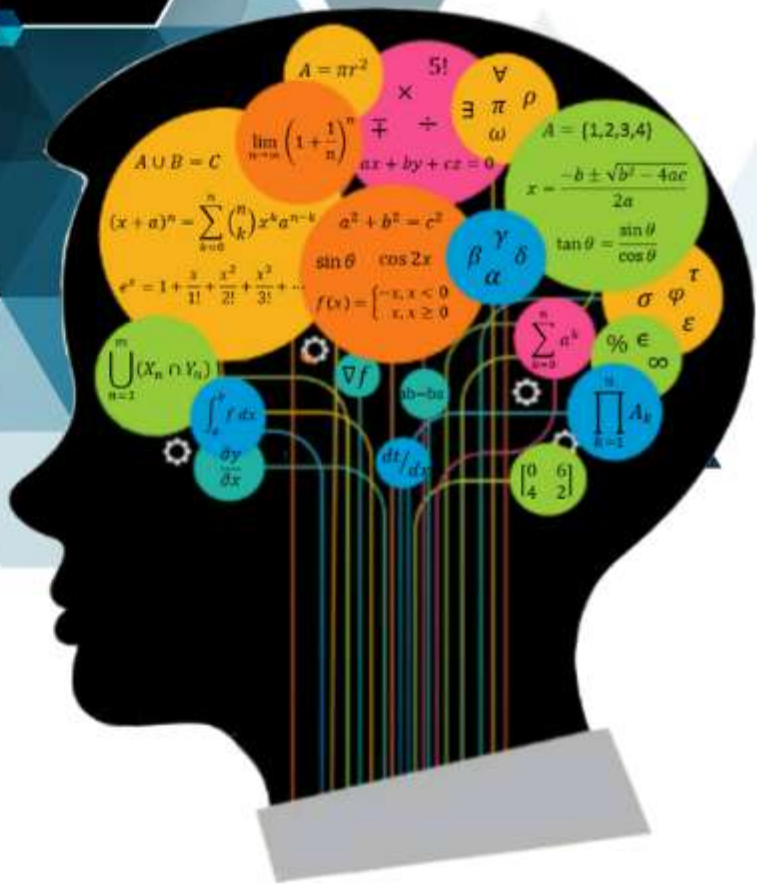
AXIOM '19

VOLUME 8

DEPARTMENT OF MATHEMATICS



Kamala Nehru College

University of Delhi

EDITORIAL TEAM

FACULTY

L to R- Dr. Mohammad Mueenul Hasnain, Ms. Divya Saigal, Dr. Pragati Gautam, Ms. Swapnil Verma

STUDENTS

L to R- Bhoomika Malhotra, Geetanjali, Sarvesh Kumari, Jaishree Garg, Devanshi Sinha

MESSAGE FROM THE PRINCIPAL'S DESK

I came across a very interesting monograph written by Boaler, 2013, who said that there is nothing called 'Math gene'. He says, "One of the most damaging mathematics myths propagated in classrooms and homes is that math is a gift, that some people are naturally good at math and some are not". I must have also said it many times that 'I am not good at math' or 'I am not a math person' but now I realize that it must have blocked the right attitude in me to learn maths. Researchers have established a clear connection between the attitudes that students have towards mathematics and how well they perform mathematically. It may be simply that some people do not have interest in math like many more such cases where one may not have interest in some or the other field of learning. But the fact remains that math is much more than just calculations, memorizations and procedures. It is a way of life on day to day basis which we all live in our materialistic life happily and willingly. There is not even a single day in our life when we can do without number in some or the other way. Those who pursue math as a course certainly have better academic and life choices. I convey my best wishes to all the students to come across the right choice in their career paths.

Dr. Kalpana Bhakuni
Principal

MESSAGE FROM THE TEACHER IN-CHARGE

"Coming together is a beginning, keeping together is progress, working together is success."

- Henry Ford

It gives me immense pleasure in conveying that the Mathematics Department of Kamala Nehru College is coming out with its annual newsletter AXIOM'19 as a showcase to the various aspects of the discipline. It will help in learning new trajectories in the subject.

As said by John Cotton Dana "Who dares to teach must never cease to learn". AXIOM '19 will open further windows in understanding mathematics in a new way.

I appreciate the effort of the students and the faculty who have worked so hard in creating this newsletter. The present issue of AXIOM'19 is a modest attempt to bring the efforts of the young women students of KNC who have picked up the gauntlets to study this discipline. I hope the readers would find it interesting and will at least get a flavor of the subject.

Dr Pragati Gautam
Teacher-in-Charge
Department of Mathematics

WORDS FROM THE EDITOR

"Without ambition one starts nothing. Without work one finishes nothing. The prize will not be sent to you. You have to win it."

It has been a pleasure working as an editor for Axiom'19- Annual Newsletter of the Department of Mathematics.

This year's edition will walk you through the unexplored world of Mathematics and it's relation to varying fields like psychology, biology, science, history and modern age facts. The recreational elements of this newsletter will enthrall you as you read along. Not only this, glimpses of the past year will surely bring back sweet memories of the bond our department shares.

I would like to extend my sincere thanks to all the Editorial Team members- **Sarvesh Kumari, Devanshi Sinha, Geetanjali** and **Bhoomika Malhotra** for working together with utmost efficiency and to all the students who have contributed by writing wonderful and inspiring articles, without which compiling this newsletter would not have been possible.

Each year, a lot of hard work is put in not only by the students but also by the staff for this one masterpiece to be published. I would like to acknowledge the same and thank our teacher coordinators **Dr. Mohammad Mueenul Hasnain, Ms. Divya Saigal** and **Ms. Swapnil Verma** for guiding us and being our constant support throughout the journey.

I would also like to extend my heartfelt gratitude to our Principal **Dr. Kalpana Bhakuni** and our department's Teacher Advisor **Dr. Pragati Gautam** for providing us the opportunity of publishing Axiom'19.

I would like to conclude with the following words-

"A dream doesn't become reality through magic; it takes sweat, determination and hard work."

Jaishree Garg

Editor, Axiom'19

B.Sc. (H) Mathematics

2nd Year

BANISHING MATHEMATICAL ANXIETY AND THE SOCIAL CONDITIONING AGAINST MATHEMATICS

Long years back when I was in the blissful space of research and teaching Mathematics at KNC, I remember organising a conference on Sociability of Mathematics wherein we had eminent researchers and practitioners, not forgetting professors, from the fields of Medicine, Cryptography, Dance, Music and Philosophy, divulging the Maths used in their specialised fields. That was an eye-opener for most of our students as they realised the exhilarating beauty and elegance of this unambiguous, logical and most precise, direct and a universal human language. Universal as each one of us and every aspect of life, has to use this language on a daily basis.

In the ancient Greek Philosopher Plato's words, Mathematics was virtually the first thing everyone has to learn, common to all arts, science, and forms of thought and all students needed to learn arithmetic. He reserved advanced mathematics for those who would serve as philosopher guardians of the city. Also, legendary scientist Richard Feyman echoed the thought of The Father of Modern Science Galileo as he stated that "Nature talks to us in the language of Mathematics"

At Emory University, USA, in December 2012, Mathematician Ken Ono and two of his students after years of research work came out with a ground-breaking formula that would enable scientists to study black holes in an entirely new way. They achieved this feat by studying a single paragraph written by the Indian Math genius Srinivasa Ramanujan, about 90 years ago. His work has formed the basis of super string theory and multidimensional physics. Ramanujan's work also introduces a new concept, that of marginal functions which can lead to understanding time travel and anti-gravity. He made breakthroughs in integral calculus which can be used to determine the gravitational effects of earth on man-made satellites and the drag force of aircraft wings. So, Ramanujan's authority is stamped. This only corroborates a mathematician's claim that every research in this discipline has immense applications at some point of time or the other. This fact goes a long way to convince students to take up Math as a profession or at least the study includes it as an optional subject wherever there is a choice.

An article captioned "Higher education in India turning into broader education" in The Hindustan Times dated 2nd January, 2019 said that India is a country with the world's largest higher education system and the interweaving of disciplines and blending learning between the sciences and arts has resulted in better prospects of students. So even if one's primary discipline is not Math, this discipline must be taken up by students, as the power of mathematical thinking equips and empowers them towards a full participation in society and to handle so much more in life. Without math-literacy, career opportunities shrink, people become easy prey of Credit Card Companies and money lenders, businesses experience a downward trend because when one is not comfortable with math, one does not question the authority of numbers.

Now comes the huge responsibility of the teachers of Mathematics to remove any social conditioning against the subject that might exist. First and foremost, we have to move away from standard anxiety-producing teaching methods as that amount to math mis-education. The need of the hour is to introduce a kind of revolutionary math teaching. If the discipline is introduced in the right manner

and with the right amount of patience, we shall be successful in reducing Math Anxiety to a considerable extent.

So let us take up some classroom practices that would help our students especially the uninitiated ones:

At the very outset, reassurance has to be given to the students that with math education, we are helping them to meet the world with confidence and courage. We need to teach them to believe in their unlimited potential. When I use the term revolutionary teaching, I don't mean what perhaps Paul Lockhart intends to say i.e. spend all of mathematics class playing chess which might be fun, but I'm just not convinced that the central and ultimate purpose of education and especially Math Education, is to entertain. The famous mathematician G.H.Hardy in fact called the chess problem, trivial math and said that no chess problem helps in the development of scientific thought.

As teachers of Mathematics, we all know that an individual with math anxiety does not necessarily lack ability in the subject. It is just that they cannot exploit their full potential as their anxiety symptoms interfere with their output and disrupt their performance due to the impact of the anxiety on working memory. Math anxiety manifests itself in various ways, including physical and psychological or there may be behavioural symptoms. Working memory has a limited capacity, and when working on mathematical problems, a large portion of this capacity is dedicated to problem solving. However, in individuals with math anxiety, much of this space is taken up by anxious thoughts, thus compromising the individual's ability to perform.

- Begin a class with a question not with answers and steps to a solution all the time. Arouse curiosity, encourage thinking and creativity. Assure them that even if they make mistakes their brain will grow. Current Math education deals with the same type of problems, sometimes 50 problems of the same type in place of say 5. That fails to inspire the students because it comprises just the template of the problem and template of the solution. No original thinking goes into classrooms. Also teachers have to have a good insight into the topic that they are teaching besides being able to predict the types of problems that students would face in the future.

  Rene Descartes, the French philosopher and mathematician said "I think, therefore I am". A thinker doubts, conceives, creates, affirms, questions, understands, denies, perceives and all this should happen in every Maths Class. A viva element especially for abstract mathematics should be a must to ensure that concepts have been understood well.

  Transmitting mathematics to anybody is a brain to brain connection. The learners have to reconstruct all that has been communicated, in their minds. So teaching Math is a dialogue and one has to constantly look for and understand the expression on the learner's face for that speaks all. We in fact look for that moment of recognition when we know that we have made the connection. That moment is the math -moment and spotting that moment and being able to identify it, is what teaching is all about. As teachers it is also a responsibility to generate an emotion and the vow reaction that just might come.

- Listening to students is important. We need to foster student-interest and success in mathematics. So even if students are unable to answer, they should be told that "Not knowing is the first step to understanding".

- Give some challenge problems. In fact, thinking problems should be included in classrooms and in examination papers for that discourages rote learning and encourages creativity. It also empowers connections between students and teachers. Math is an open-ended creative act. This is what research is all about. In fact Einstein called "play" the highest form of research so let students play with maths. A mathematics club with creative and thought-provoking

games is a great way to make maths belong to the students rather than the latter belonging to Maths.

A potential solution for all that is the mathematical preparation of our teachers. Mathematical reasoning and understanding is an inherent part of Math education. So teachers need to have a sound mathematical background in order to teach effectively. One method to help address the issue of math anxiety is to ensure that teaching programs are reinforcing positive attitudes towards math, and helping candidates solidify their grasp on mathematics. Students develop mathematical anxiety at an early age, often as a result of learning from teachers who are themselves anxious about their mathematical abilities in certain areas. In many countries, would-be math teachers are required only to obtain passing grades of 50% or so in mathematics exams. How would such teachers be able to handle Math-anxiety in their students?

Teachers in colleges and Universities must be cognizant about the subsequent levels (e.g. from UG to PG) or from subjects like real analysis to Metric spaces to Topological spaces as students have to be mathematically literate to understand a succession of ideas in order to create new facts. So teachers should be able to engage students in real mathematical discourse.

Usually the first college-level math course is calculus and some algebra-based courses. These are normally taught in schools. It is quite perplexing that even though students have been exposed to topics like Set Theory, Calculus and algebra in school, when they arrive in college; one needs to repeat it all as their basic concepts are not at all clear. The teacher's role comes in here.

- Remedial Programmes/ bridge course - We can substantially improve our system of mathematics education with remedial programs in higher education wherever there is a gap as we have to often work with students who come to us with mathematical deficits and different levels of Math anxieties *Also they come from all over the country with different backgrounds. Mathematics is ruthlessly cumulative*, all the way back to counting. However, a student who doesn't understand arithmetic will struggle with algebra and statistics. A student who doesn't understand algebra will struggle with calculus and many courses in the sciences but there are no quick fixes.

With less emphasis on right or wrong and more emphasis on approach and process, teachers can help alleviate students' anxiety about math in a big way. It however remains a challenge for the Math Faculty as the phobia of the discipline is vast-spread. But losing hope is not the answer. Let us together face the titanic challenge and pledge to overcome the same.

Dr. Rita Malhotra

Former Principal

Kamala Nehru College, University of Delhi.

PELL'S EQUATION

There have been great advancements in the field of algebra concerning the explication of different forms of equations, varying greatly from simple forms such as $ax + c = by$, to complex forms as

$$ax^2 + bxy + cy^2 = z^2$$

Here, we will look slightly in more detail at solution(s) of Pell's equation:

$$\boldsymbol{Nx^2 + 1 = y^2}$$

The Pell's equation was solved by Brahmagupta (628 AD), later to be improved by Bhaskara II (1150 AD). This led some historians, including C Srinivasiengar, to suggest that:

This equation will be known as Brahmagupta-Bhaskara equation.

The complete theory underlying the solution of Pell's equation was interpreted by Lagrange in 1767, as it fundamentally rests on the theory of continued fractions. Contained within this brief discussion is a small computer code for the *Maple* mathematics package that uses the Brahmagupta type solution of Pell's equation to derive extremely accurate square roots.

The Pell's type of equation was known in India as *Varga Prakriti*, or "equation of the multiplied square", where prakriti means coefficient and refers to the coefficient *N* (where N is a positive integer).

The following is an example of great interest established in the Bijaganita of Bhaskara, which is also of the form of a problem Fermat set to fellow mathematician Frenicle in 1657. In solving this equation, the *chakravala* method is prodigious as it requires just a few 'easy' steps as compared to Lagrange's solution that requires complex use of continued fractions.

To understand it deeply let us calculate the solution of

$$\boldsymbol{67u^2 + 1 = v^2}$$

Firstly, take the auxiliary equation,

$$67\times1^2 - 3=8^2$$

Then using Bhaskara's lemma, where $Na^2 + k = b^2$, and *a, b, k* are the integers (1, 8 and -3) in the auxiliary equation above, (*k* being positive or negative) then:

$$N\left(\frac{am+b}{k}\right)^2 + \frac{(m^2 - N)}{k} = \left(\frac{bm+Na}{k}\right)^2$$

Thus,

$$67\left(\frac{1\times m+8}{-3}\right)^2 + \left(\frac{m^2-67}{-3}\right) = \left(\frac{8m+67\times 1}{-3}\right)^2 \ldots (1)$$

Then, the method of *Kuttaka* implies the solution of $\frac{(m+8)}{-3}$ = an integer, is $m = -3t + 1$

Putting $t = -2$, we get $m = 7$, which makes $[m^2 - 67]$ least.

By substituting this value, equation (1) reduces to:

$$67 \times 5^2 + 6 = 41^2$$

Again, by Bhaskara's lemma:

$$67\left(\frac{5n+41}{6}\right)^2 + \left(\frac{n^2-67}{6}\right) = \left(\frac{41n+67\times5}{6}\right)^2 \quad \ldots (2)$$

Then the solution of $\frac{(5n+41)}{6}$ = a whole number which is $n = 6t + 5$. $[n^2 - 67]$ is the least for the value $t = 0$, that is, when $n = 5$. Equation (2) then becomes:

$$67 \times (11)^2 - 7 = (90)^2$$

$$67\left(\frac{11p+90}{-7}\right)^2 + \frac{p^2-67}{-7} = \left(90p + 67 \times \frac{11}{-7}\right)^2 \quad \ldots (3)$$

The solution of $\frac{(11p+90)}{-7} =$ an integral number, is $p = -7t + 2$. Taking $t = -1$, we have $p = 9$; and this makes $[p^2 - 67]$ least. Substituting that into (3), we get:

$$67 \times (27)^2 - 2 = (221)^2$$

By applying Principle of Composition of Equals, we get from the above equation:

$$67(2 \times 27 \times 221)^2 = ((221)^2 + 67 \times (27)^2)$$

$$67(11934)^2 = (97684)^2$$

Dividing out by 4 we have:

$$67(5967)^2 + 1 = (4882)^2$$

Hence, $u = 5967$ & $v = 48842$ is a solution of the equation $67u^2 + 1 = v^2$.

Now, let us conclude this discussion of Pell's equation by illustrating Brahmagupta's method for calculating square roots with the following example. The method was used by Brahmagupta to find the square root of the integer N, when $Nu^2 + 1 = v^2$, and solutions for *u* and *v* are known.

If $N = 5$, then $v^2 = 1 + 5u^2$. It implies $5 = (v^2 - 1)u^2$ and that $\frac{v^2-1}{u^2} \gg \frac{v^2}{u^2}$ is the key to finding the square root of 5, as $5 = \frac{v}{u}$. With ease we can identify $v = 9$ and $u = 4$ as solutions to this equation and we see

$$5 \gg 9/4 = 2.25, (5 = 2.236067978\ldots)$$

Clearly the larger *v* and *u* are, the better the approximation is. This can be shown using the following *Maple* programme:

```
> n:=5:
> f:=(u,v)->(2*u*v,v*v+n*u*u):
> m:=0:
> u:=4
> v=:9
> while m ≤ 5 do
> m:=m+1;
> print(u,v,evalf(v/u,20), evalf(v/u-sqrt(n),50));
> a:=f(u,v);
> u:=a[1];
> v:=a[2];
> end do:
```

The output gives the following:

$4, 9$ (solutions of u and v)

2.25000000000000000000 (v/u to 20 decimal places)

$0.013932022500210303590826331268723764559381640388 5$ (error between v/u and 5)

By the 5th step, the following solution is given:

$2584035442742916153 6, 5778078906241926144 1$ (5th pair of solutions for u and v)

2.2360679774997896964 (v/u to 20 decimal places)

$0.3348791201 \times 10^{-}39$ (error)

This result is extremely precise, and the method must be considered brilliant given it was derived by Brahmagupta in 628 AD.

-Yachna Hasija

3rd Year

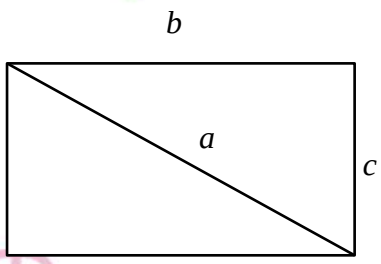
MATHEMATICS IN THE SERVICE OF SULBA SUTRAS

The Indo-Aryans, who originated from the north of the sub-continent, followed the Vedic religion. Through the works of Vedic religion, we gain the first literary evidence of Indian culture and hence mathematics. Although, the Vedic works, Vedas and Vedangas (later Sulba Sutras) are written in Vedic Sanskrit and are religious in content but they cover a large amount of astronomical knowledge, thus a significant knowledge of mathematics as well.

The 'traditional' material along with further related elaboration of Vedic mathematics is represented by the later Sulba-sutras. Further to the expansion of topics in Vedangas, the Sulba Sutras contain a number of significant developments which include first 'use' of irrational numbers, quadratic equations of the form $ax^2 = c$ and $ax^2 + bx = c$, unarguable evidence of the use of Pythagoras theorem and Pythagorean triples, and evidence of a number of geometrical proofs.

Pythagoras theorem and Pythagorean triplets, as found in the Sulba Sutras:

If we stretch a rope along the length of the diagonal of a rectangle, then it makes an area with the vertical and horizontal sides (a triangle).



In other words,

$$a^2 = b^2 + c^2$$

The following are the examples of Pythagorean triples given as the sides of right angled triangles:

5,12,13

8,15,17

12,16,20

12,35,37

Among the Sulbas, so far the four major and most mathematically significant are those composed by Baudhayana, Manava, Apastamba and Katyayana. However, 20 years ago, it was claimed that there are three further Sutras, 'composed' by Maitrayana, Varaha and Vadhula. The name Sulbasutra means 'rule of chords' which is another name for geometry.

N Dwary states:

"They offer a wealth of geometrical as well as arithmetical results."

R Gupta similarly claims:

"The Sulba-sutras are (quite) rich in mathematical contents."

This is not particularly compelling evidence but does suggest that the composers of the sulba-sutras may have had a greater depth of knowledge than is generally thought of. Moreover, many suggestions for the value of π are found within the sutras. Surprisingly, it covers a wide range of values, from 2.99 to 3.2022.

Around 800 B.C., it was first found in the Baudhayana sutra that Pythagoras's theorem and Pythagorean triples arose as the result of geometric rules. In the later work of ***Apastamba***, it is also implied that Pythagorean triples are found in his rules for altar construction. Altar construction also led to the discovery of irrational number- a remarkable estimation of $\sqrt{2}$ is found in three of the sutras. The method for approximating the value of $\sqrt{2}$ gives the following result:

$$\sqrt{2} = 1 + \frac{1}{3} + \frac{1}{3.4} - \frac{1}{3.4.34} = 1.1412156 \ldots$$

Many scholars argued in attempt to deprive Indian Mathematics its due credit, that Indians believed the above value of $\sqrt{2}$ exactly, which would not indicate knowledge of the concept of irrationality. However, in Indian works, it is stated that various square root values cannot be *exactly determined*, which strongly suggests the initial knowledge of irrationality. Undeniably, an early method for calculating square roots can be found in some Sutras. It involves repeated application of the formula:

$$\sqrt{A} = \sqrt{a^2 + r} = a + \frac{r}{2a}, \; r \text{ being small}$$

Application of formula for calculating square roots:

If $A = 10$, $a = 9$ and $r = 1$.Thus, $\sqrt{10} = \sqrt{3^2 + 1} = a + \frac{r}{2a} = 3 + \frac{1}{6} = 3.16667$ in (modern) decimal notation and $\sqrt{10} = 3.162278$ to six decimal places on a calculator.

So, after only one application of the formula, an accurate value has been calculated.

C Srinivasiengar thus states:

"The credit of using irrational numbers for the first time must go to the Indians."

Many of the Vedic contributions to mathematics have been neglected or worse. And when it first became apparent that there was geometry contained within works that were not of Greek origin, historians and mathematical commentators went to great lengths to try and claim that this geometry was Greek influenced (to a greater or lesser extent).

It is true to say that none of the methods of Greek geometry are identifiable in Vedic geometry, but this merely serves to support arguments that it is independently developed and not in some way borrowed from Greek sources.

In light of recent evidence and more accurate dating, it has been even more strongly claimed by A Seidenberg (in S Kak) that:

"Indian geometry and mathematics pre-dates Babylonian and Greek mathematics."

This may be an extreme outlook seeming likely to the fact that there were an ocean of ideas in the Ancient world, but there is little doubt that the vast majority of Indian work is original to its writers. It may lack the cold logic and truly abstract character of modern mathematics but this observation further helps to identify it as uniquely Indian. Of all the mathematics contained in the Vedangas, it is the definite appearance of decimal symbols for numerals and a place value system that should perhaps be considered the most phenomenal.

- Sarvesh Kumari

3rd Year

CAUSES AND PREVENTION OF MATH ANXIETY

Right from kindergarten, we are introduced to numbers and how they form the subject Mathematics. In elementary school, we learn other mathematical operations and skills which eventually decide our equation with the subject of equations itself! Not all have an interest for the subject. Study proves that if some students find mathematics interesting and challenging, there are some others who dread mathematics so much so that they don't even like hearing the subject's name.

Naturally, this anxiety, ***Math anxiety*** that gets into one's mind does not happen all of a sudden. The process is slow and this anxiety tends to develop over the years. There can be many logical reasons to prove why students develop math anxiety. Do you start sweating or your heart races at a faster pace when you hear or try to solve a mathematical problem? If yes, then you probably have the Math Anxiety!

Explanations to the arousal of Math Anxiety:

Most of the times, students develop math anxiety when they're expected to learn extensive concepts of mathematics. This can happen when they have *yet not mastered the basic math skills*. Just like a solid building cannot be constructed when the foundation isn't strong, expecting a child to gain additional math skills without them having mastered their basics can lead to a *lack of self-confidence* and anxiety about math.

Let us suppose that your friend always excels in the subject and never misses an opportunity of a perfect score. *Fear of failure, self-doubt and your reluctance* to solve questions overpowers you.

Fear of public embarrassment can demotivate and demoralize to an extent that you stop pushing yourself when it comes to solving questions. The instances wherein you cannot come up with the right answer or are slower than your course mates are the reasons you start feeling that people will mock you for being slow.

The time constraints while answering a class test can make a student nervous too. Not being able to perform well and *forgetting concepts* that they have no problem in remembering at home can cast a negative impact on not only the grades but also increase the student's fear from calculations and numbers.

Numerophobia or the fear of numbers derives out of math anxiety. Researchers have found that difficulty in dealing with numbers leads to math anxiety in young students. Moreover, a recent research has shown that children of age group 6-10 have also said that mathematics makes them anxious.

How can we help get rid of Math Anxiety?

The tools that have been created to cure math anxiety are nothing but ***interventions***. Let's go through some of these interventions that researchers have come up with.

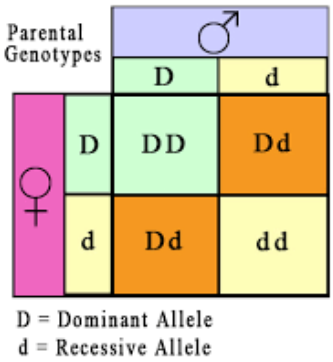
- *Practice is the key to success*. Developing a habit of practicing and *clarifying your doubts* with your teachers will help you clear your basic concepts. Do not feel shy in confronting your teacher; they would never disagree in helping you out!
- *Stop comparing yourself with others*. Take your own time in solving problems; don't think about how slow you are or how fast you were able to complete the question. Go at your own pace. Time yourself and you'll stay away from the anxiety.
- Don't take your exams in a state of panic. Relax and take *proper sleep before taking tests*. Try to read the question first, understand it and then start solving. Be calm and treat mathematics as a fun subject.
- *Make the subject more interesting*. Find tips and tricks to memorize formulae and have a habit of jotting down the important formulae and *making notes*. The more you write the more you remember!
- *Reframe your anxiety*. Write down how you feel about the subject and vent it out before you begin studying the subject. Make sure you kick out the fear from your brain. Talk to your peers and try seeing tests and assignments as a challenge and not a threat.

Lastly, talk to your parents and teachers and gain some *positive reinforcement*. Change your perspective towards the subject and you'll see a change in no time!

-Jaishree Garg
2nd Year

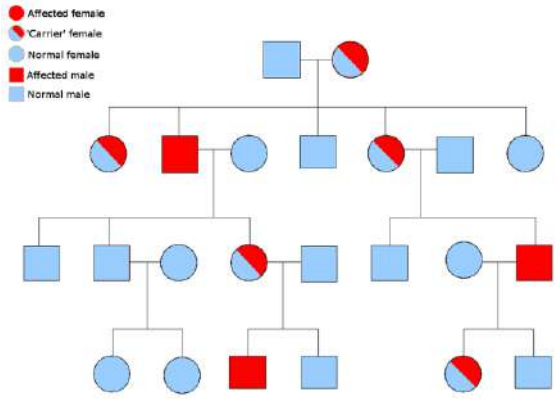
USE OF MATHEMATICS IN HEREDITY

This article deals with the use of Mathematics in the field of Heredity. Heredity is a branch of Biology which deals with inheritance and variation. In biology, inheritance is the transfer of characters from one generation to another whereas variation is the degree by which the progeny differs. The DNA (Deoxyribonucleic acid) is the basis of genetics where gene is a segment of DNA coding for a particular trait. Genes which code for a pair of contrasting characters are called an allele.



For long, mathematics had been kept away from Biology which was seen as a theoretical subject. In mid-19th century, Gregor Mendel was the first one to apply statically analysis and mathematical logic to problems in Biology. He conducted an experiment on garden pea –Pisium sativum. Mendel proposed that

during gamete formation by meiosis, the allele of the parents segregate from each other. This allele segregation is random, so there is a 50% chance of gamete containing either type of the allele.



In light of Mendel's study, Reginald C. Punnett gave a graphical representation to calculate the probability of all possible genotypes of offspring in a genetic cross. The possible gametes are written on two sides, usually in the top row and the left column. All the possible combinations are represented in boxes below in a square table, which generates a square output form.

The genetic ratio is mathematically condensed to the form of a binomial expression

$$(ax + by)^2 \quad TT : Tt : tt = \frac{1}{2} : \frac{1}{4} : \frac{1}{2}$$

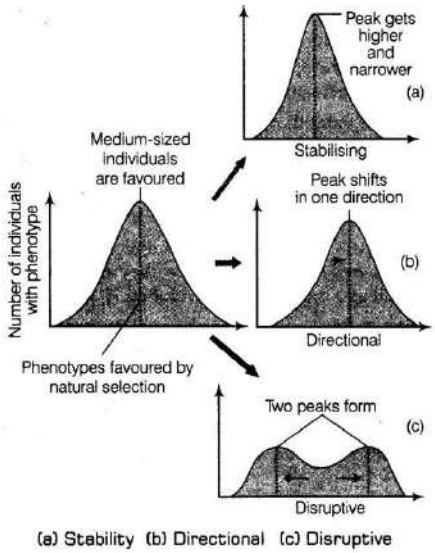
$$\left(\frac{1}{2}\ T + \frac{1}{2}\ t\right)^2 = \left(\frac{1}{2}\ T + \frac{1}{2}\ t\right)\left(\frac{1}{2}\ T + \frac{1}{2}\ t\right) = \frac{1}{4}\ TT + \frac{1}{2}\ Tt + \frac{1}{4}\ tt$$

Genes of an individual, parents and of all possible types of fertilized egg which can arise from them are set, subsets and functions. The relation between them is a part of mathematics. Sets can be represented by letters, relations and operation and also by symbols. For example: set of parent P of an individual is made of a male parent m and a female parent f, therefore $P = \{m, f\}$.

For example: Trait=tall, set of gene $= \{T, t\}$.

These two elements-'m' of male parent and 'f' of female parents are known as alleles.

When a male gamete fuses with a female gamete, it results in the formation of a fertilized egg or zygote, in which each gene is again made up of two elements or alleles. Hence, the genes of the living organisms are seen as ordered pairs of elements called alleles where each offspring is an element of the Cartesian product. After unraveling the complexity of genes and with discovery of DNA, attempts were made to elucidate the structure of DNA to understand the genetic makeup of different species. George Gamow used permutation to find the number of codons. He argued that there are four bases that have to be coded for 20 amino acids provided the code is a combination of those bases. He suggested that in order to code for all the twenty amino acids, the code should be made of three nucleotides. This was a very bold proposition as a permutation combination of $4^3\ (= 4 \times 4 \times 4)$ would generate 64 codons, thereby generating many more codons than required. Later, Hargobindo Khurana succeeded in providing a proof that a codon was a triplet in which one codon codes for one amino acid but one amino acid was coded by more than one codon. While others worked on the wonders of DNA, Hardy Weinberg on heredity accounts worked on Darwinian process of natural selection. He then proposed the Hardy-Weinberg Principle which stated that the allelic frequency in a population is stable and constant from generation to generation, that is, the gene pool (total genes and their alleles in a population) remains constant. This is called genetic equilibrium. Sum total of all allelic frequency is one.



(a) Stability (b) Directional (c) Disruptive

Suppose, in a diploid organism-

Frequency of occurrence of allele 'A' $= p$

Frequency of occurrence of allele 'a' $= q$

All the possible combinations $= AA, aa, Aa, Aa = p \times p\ , q \times q\ , p \times q\ , q \times p = p^2, q^2, pq\ , qp$

Then according to Hardy-Weinberg principle:-

Sum of allelic frequency= 1

$$p^2 + q^2 + pq + qp = 1 \Rightarrow p^2 + q^2 + 2pq = 1 \Rightarrow (p+q)^2 = 1.$$

This is called genetic equilibrium. When the frequency measured differs from the expected value, the difference indicates the extent of evolutionary change. Nowadays, Pedigree analysis is the most applied field of extensive usage of mathematics that is used to decipher disorders generated due to genetic variation and expression of mutant gene.

From the above discussion, we can conclude that Mathematics is used as a tool that supports and enriches heredity, and helps in reducing genetic diseases.

-Injila Naeem

2nd Year

A GLIMPSE OF 2018

OMICRON'18

The Annual Mathematics Day, "Omicron" held on October 9, 2018 was meticulously organized by the Department of Mathematics.

The event began with an inaugural lecture by Mr. Girish Mishra, a Scientist 'E' SAG, Defence Research and Development Organization. Mr. Girish Mishra apprised the students by discussing about Linear algebra and its applications in Artificial Intelligence, Block chain technology, Quantum computing and other scientific domains.

The Paper Presentation Competition was the first event in the lineup of Omicron after the talk. Prangana Kashyap (KNC, DU) and Gariyoshi Das (JMC, DU) bagged the first position winning a cash prize of Rs.2000; Jaishree Garg and Devanshi Sinha (KNC, DU) earned the second position and cash prize of Rs.1500. The other events which were organized by the students included PIC-to-WORD, Cipher-Decipher & Treasure Hunt.

FAREWELL'18

Our seniors have always been a source of inspiration for us. With happy tears, we bade adieu to our beloved seniors on April 23, 2018. The hardworking bunch of students of Batch 2015-2018 will be missed.

FRESHERS'18

Fresher's 2018 was organized for the first years of the department. The event acted as a bonding session for our students and teachers. From mimicry to showcasing graceful dance forms and melodious songs, the hidden talents of our first years were witnessed in the event.

ENCRYPTION IN WHATSAPP

Today, WhatsApp is one of the most favoured mobile messaging software that allows people to exchange messages (including chats, group chats, images, videos, voice messages and files) and make calls around the world.

Released in April 2016, the latest version of 'WhatsApp' uses WhatsApp client software, in which the conversations and calls between the sender and receiver are "end-to-end", encrypted.

What does end-to-end encryption mean?

In end-to-end encryption, only the data is encrypted. The headers, trailers, and routing information (i.e. how the data is transferred from the sender to the receiver through a network) are not encrypted. The Signal Protocol, designed by Open Whisper Systems, is the core for WhatsApp's end-to-end encryption.
End-to-end encryption makes sure that a message that is sent is received only by the predetermined recipient and none other. This protocol is designed in such a way that a third party or even WhatsApp itself cannot poke into conversations between intended recipients, thus, developing a very strong messaging platform.

How is end-to-end encryption in WhatsApp implemented?

End-to-end encryption in WhatsApp is implemented by using the 'Asymmetric Cryptography' or public key systems. The fundamental aspect of 'Cryptography' is to hide information during transfer and make it available only for the intended recipients.

Cryptography involves the use of some terms like:

***Plain text*:** The text or message that needs to be hidden and transmitted to the intended recipients.
Cipher text: The text that has been transformed by algorithms and is meaningless.
***Encryption*:** The process of converting the information from *'plain text'* to *'cipher text'*.
***Decryption*:** The process of converting the information from *'cipher text'* to *'plain text'*.
***Algorithm*:** The complex mathematical formula that is used to convert *'plain text'* to *'cipher text'*.

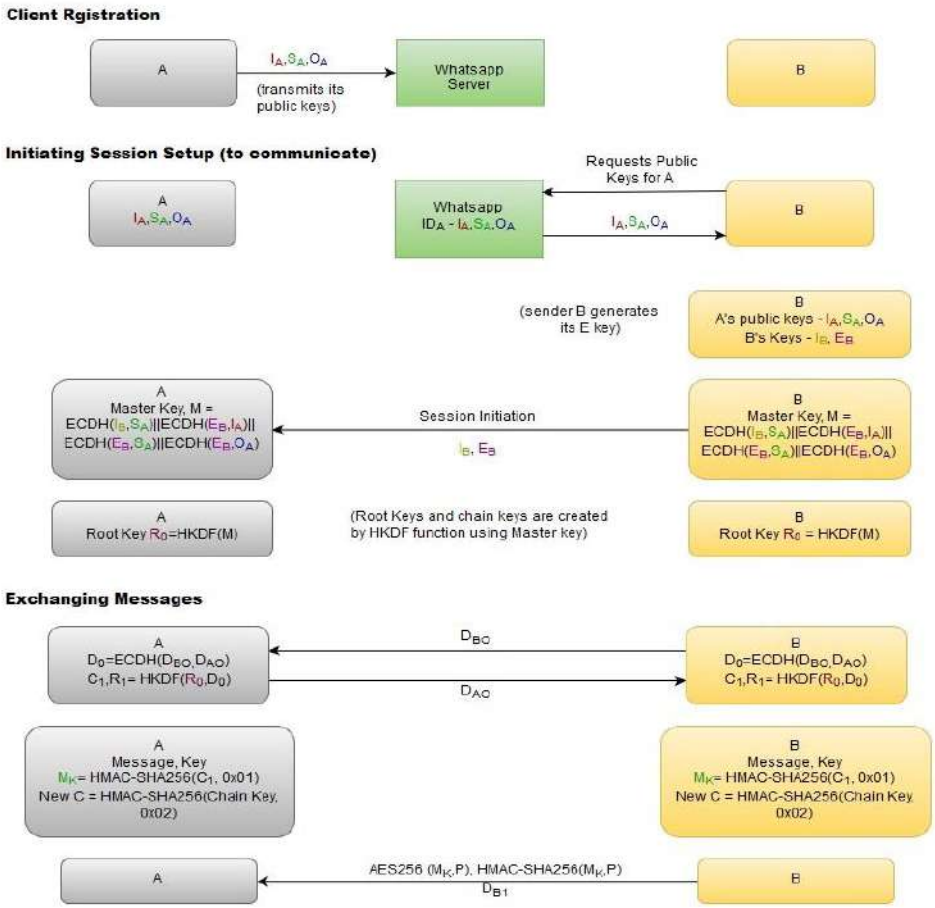
Here, both the sender and the receiver have similar or different kind of "keys" to encrypt and decrypt the message and indulge in Asymmetric Encryption.

A "key" is a value that consists of a large sequence of random bits. The larger the key size, the more difficult it will be to solve the algorithm.

In Asymmetric Encryption, a public key is used to encrypt the message and a private key is used to decrypt the message. In asymmetric cryptography, the public key is widely known whereas the private key is kept protected. Though the two keys are mathematically related, one will not be able to calculate the private key even if the public key is known.

Keywords used:

Public Key types:
• Identity Key Pair (I) - generated at install time
• Signed Pre Key (S) - generated at install time
• One-Time Pre Keys (O) - for one time use, generated at install time and replenished as needed
• Ephemeral Key for session initiation (E)
• Ephemeral Key for chain key generation (D)



Session Key Types:

- Master Key (M) - used to derive root key
- Root Key(R) - used to create Chain key
- Chain Key(C)-used to create Message key
- Message Key (M_k) - used to encrypt messages {Subscript denotes round of key}

Cryptographic functions:

- ECDH(X, Y): calculates the shared secret if X and Y are the ECDH public keys of two entities
- HKDF(X): HMAC-based key derivation function
- AES256 (K, P): encrypts the plain text P with 256 bit AES using key K
- HMAC-SHA256 (K, P): computes the HMAC using SHA256 algorithm and key K of plaintext P

-Geetanjali

2nd Year

MEANINGLESS NUMEROLOGY OR DEVINE SYMMETRY

Have you ever wondered how a subject like Mathematics could possibly play a role in deciding your destiny? No? Well, Pythagoras did and he believed that the whole world could be explained in a sequence of numbers and so be it, emerged the theory of numerology. Numerology, also known as the mathematical key to the mysteries of Universe is a branch of study having a significant connection with numbers and the theurgy. It can be referred to as a complex arithmetic system that reveals the character, experience and personality traits of a human being through the evolution of numbers and the manner in which they influence human life.

Many scholars recognize Egypt and Babylon as the birthplace of numerology. Also, there is compelling evidence that numerology was used thousands of years ago in the cultures of India, China, Japan, Babylon, and Egypt before the Greeks and Romans even started learning it. However, the modern day origins of numerology are credited to the Greek philosopher, Pythagoras.

In the contemporary world, a vast majority of mathematicians consider numerology to be a mystical pseudo-science that adjures people's cognitive dissonance, and that it is certainly not mathematics. On the contrary to the modern reasoning behind numerology, this was not the case with many of the historic mathematicians. Several mathematicians, from Pythagoras to Newton, believed in numerology. Along with the cognitive biases being what they are, it is expected that quite a number still do believe, just like those scientists who somehow manage to carry out the actual research while themselves not believing in evolution. In general, there are 3 types of numerology:

Chaldean Numerology

Also known as "Mystic Numerology", Chaldean numerology is the oldest functioning numerology system that derives its roots from the Sumerian Civilization. While Chaldean Numerology is considered to be more accurate, it's less popular because it is not very easy to master, and the alphabet values are not in as systematic an order as the Pythagorean Numerology.

Kabbala Numerology

Kabbala numerology system is originated from the Hebrew. It includes and analyzes only the name of an individual and not the date unlike that in the other systems. That's why people consider it less efficient and it is not as popular as other numerological systems.

Pythagorean Numerology

Pythagorean or Western Numerology is among the most popular systems of self-help methods organized by Greek philosopher and mathematician Pythagoras, who combined the mathematical disciplines of the Phoenician, Arabic, Egyptian, Druid and Essene sciences. In this system each Western alphabet has a numerical value from 1 to 9 attached to it.

Core Numbers

In essence, there are five building blocks or "core numbers" that make up the Numerology of a person: Life Path number, Expression number, Personality number, Heart's Desire number and lastly Birth Day number. Each one of these is based on one's full birth name and/or full birth date and/or derived from only the number consonants or from just the vowels in one's name. It is said to have a deep-rooted impact on the type of person one presently is.

The main idea behind numerology is that everything in the universe is both fabricated and affected by numbers that are considered a powerful symbolic expression affecting all aspects of nature, technology and the divine. A different style of addition, known as the "Fadic System" (also referred to as natural addition) is applied to reduce multiple-digit numbers to a single digit. Using this methodology, one continues to add together two digits until a single digit number is obtained. So for example, rather than perceiving the number 23 as a two-digit number- twenty three, it is comprehended in its separate parts as a 2 and a 3. Following the above mentioned method of natural addition, the two digits are added together to come up with a single digit:

$$23 = 2 + 3 = 5$$

Here, each single digit calculated using the above method when analyzed through numerology gives specific personalized information about that person. Now, to those of you wondering to believe or not to believe in this mystical revelation, I would like to suggest that sometimes it is better to have a mind opened by wonder than one closed by conviction.

-Devanshi Sinha

2nd Year

PRODIGIOUS FEATS AGAINST PREJUDICES

"But Mathematics is not...feminine".

Recent times have seen improvement in the skewed sex ratio in the field of Science, Technology, Engineering & Mathematics or more commonly known as STEM. Women, in greater numbers are coming up in terms of pursuing subjects in pure & applied Sciences which has seen a significant increase from the mere 20% to 55% participation. However, this does not translate to absolute elimination of gender bias against women in a still existing patriarchal culture where sadly even today, the perception of women being weaker in comparison to men in the concerned field exists. In fact this is where the larger discouragement towards furthering their education, stems from. In addition to that, the cultural and racial bias adds greater disadvantages to women trying to find the motivation to thrive.

But a pleasant turn of events is finally pushing our modern society to come up with creative ideas and inspirations, encouraging the participation of women in this arena. A majorly male dominated film & television industry showing Math Geniuses like Will Hunting from "Good Will Hunting", Malcolm from" Malcolm in the Middle " or John Nash from "A Beautiful Mind" showcased only male prodigies and their excellent contribution in the field of Mathematics while the portrayal of women had been disappointedly mere. But thanks to popular culture and increasing movements, today Oscar winning movies like "Hidden Figures" starring the 3 black women as Aeronautics & Space Scientists and major theatrical productions such as "Photograph 51" starring the legendary woman role model Nicole Kidman as a DNA Scientist has tremendously enhanced the contribution of woman in applied mathematics and science and also tried to deal with puzzling issues of bigotry and pseudo-societal values.

Even if this doesn't completely solve the problem of under representation of women in the aforementioned industry, today at the least it recognizes the immense importance of the same and is actively promoting movies highlighting and popularizing the concept of women in challenging fields.

But thankfully, today, we don't only have literature and cinemas to influence young female minds but women marvels in reality such as the Iranian Mathematics Prodigy: Maryam Mirzakhani. Genius Personified, she was the first and to-date only female Mathematician to win, the quadrennial Fields Medal which is one of the most prestigious awards in the field of Mathematics, often equated to that of the Nobel Prize.

"Overwhelming" is only an understatement when talking about her qualifications. Born on 12th May, 1947 she initially wanted to become a writer but later on was swooned by Mathematics. Her work on theoretical mathematics with a combination of Theoretical Physics enabled her to get the closest to accurate measures and formulae of complicated shapes such as amoeba, doughnuts and spheres et cetera and went on to solve mathematical challenges that physicists have struggled with, for centuries: the trajectory of a billiard ball around a polygonal table.

Battling against stereotypes of cultural pressures as a Farsi Muslim Woman and racial bias as a woman of colour, she successfully completed her education from the prestigious Harvard University and went on to become a Professor of Mathematics at Stanford University. In the face of a persisting difficult time for women making it in the sciences, she is an embodiment of inspiration and motivation for millions of young girls and women across nations.

Compelling stories by the Indian Origin- Nilanjana Datta, Professor on Quantum Information Theory under the Department of Applied Mathematics & Theoretical Physics at the University of Cambridge, on battling sexist comments and facing doubts and criticism on possibility of striking a balance between her career and her family, she was one of the innately brilliant women to have overcome it all, purely out of her passion and love for Mathematics & Physics. Her inquisitiveness and desire to provide ground breaking solutions to complex theories surely made her stand out of the crowd.

Shakuntala Devi, commonly referred to as the "human computer" for her impeccably fast calculations, Sujatha Ramdorai on her beautiful work on studying deeper concepts of the number theory using algebraic techniques making her a recipient of the prestigious Ramanujan Prize and the Shanti Swarup Bhatnagar Award, and many more such incredibly talented women who had the edge of defying against all odds and following their passion to become who they are today are stories that probably aren't told enough.

These prodigious feats from the age-old perceived "weak and fragile women" clearly have a resonating message to send to our young and impactful readers- Don't let the confusing patriarchy dictate your goals and choices and have the "fearless ambition" driven by great intellectual curiosity and success.

-Bineeta Rath

2nd Year

MATHEMATICS AND THE HISTORY OF RELIGION

We consider religion to be the place, where a culture establishes its contact with the transcendent reality. Nevertheless, the objects of mathematics such as numbers or geometrical figures also transcend the physical world. This means that mathematics is also based on transcendence of physical reality. We try to show that this common basis, namely the transcendence of the physical world, gives rise to some common patterns in the development of religion and of mathematics. In my opinion, religion creates the basic means and ways of transcendence, which are used in the whole culture, including mathematics. So, the common patterns in the development of religion and mathematics are not accidental. They belong to the very nature of these subjects.

Religion is mostly not paralleled with mathematics because a principal difference is evident at first sight and this complicates similar parallels. Religion is based on faith, which can rarely be justified by the believer who is often not even able to explain it. By contrast, mathematics is knowledge justified on a rational basis, which is strictly proved by deduction, the faith being thus irrelevant to its acceptance.

In spite of these differences, there are certain points of contact between religion and mathematics. One of them is the Pythagorean School, which stands at the beginnings of what is currently named mathematics. Pythagoras is the author of the term mathematics itself (it originally meant knowledge, teaching, science, art) with the meaning as used till today, namely as a denotation of arithmetic, geometry, and other exact disciplines together. Pythagoras was the one to discover the idea of a proof. On the other hand, Pythagoras is also a great figure from the perspective of the development of religion. The character of the Pythagorean School was that of a religious sect with strict moral regulations, believing in reincarnation and dealing with esoteric disciplines.

Pythagoreanism is of course not the only point of contact between mathematics and the sacred. There is another teaching, where we can find relations between mathematics and religion, namely Kabbalah. Kabbalah is a Jewish doctrine seeking numbers hidden in the sacred Torah trying to uncover the concealed message of the Scripture by various mathematical calculations. Similarly, in some sacred literature of the ancient Indians, we can find different kinds of mathematical knowledge.

These examples open a possible route of investigating the relationship between mathematics and religion. This might be denoted as **hidden mathematics**, the mathematics that we find in sacred texts or sacral buildings. It is the mathematical knowledge concealed in the Torah, the Veda and the Koran or in the pyramids, temples and cathedrals.

The second route, which opens up for the investigation of the relationship between mathematics and religion, is the exploration of the process of **mathematical creation**. We approach here the very center of mathematics, the milestones in its history. The parallel between mathematics and religion is in this case based on the fact that many renowned mathematicians describe the process of mathematical creation as a contact with a mystery, a contact with something that transcends humanity. The point is to analyze such moments, when prominent mathematicians face the radical crossing of the boundaries of knowledge and when they face the mystery directly. Many of them, for example Albert Einstein, describe this moment as a moment of contact with the higher harmony of the universe and often speak about this experience directly in the religious terminology.

In his lecture on "S*ome tendencies in the development of mathematics*", Igor Shafarevitch, the outstanding Russian mathematician, pointed to a similar aspect in connection with the discovery of

non-Euclidean geometry: *"After Lobachevski and Bolyai laid the foundation of non-Euclidean geometry independently of one another, it became known that two other men, Gauss and Schweikart, also working independently, had both come to the same results ten years before. One is overwhelmed by a curious feeling when one sees the same designs as if drawn by a single hand in the work done by four scientists quite independently of one another."*

Shafarevitch did not speak about any marginal current of mathematics. He described one of the central events in the development of mathematics in the nineteenth century. He thus showed that in the very center of the main stream of mathematics, we face the phenomena which according to him, points to the higher aim and deeper mission of mathematics.

Shafarevitch explicitly called this deeper sense of mathematics *"A supreme religious goal of the spiritual activity of mankind"*.

-Bhoomika Malhotra

2nd Year

MYTHS ABOUT MATHEMATICS

Mathematics is used by us knowingly or even unknowingly in almost all our daily endeavors- from basic counting of items to simple arithmetic while buying goods at the supermarket. This we do without any preconceived notion or myth about the subject. Then why do people treat this subject as being very difficult, odd and something not everyone can do?

There are different myths about the subject.

Girls cannot do math or men are better at the subject than women.

No scientific research proves this as true. If people consider it to be true then why do so many women colleges offer mathematics honors as one of the courses in their college? We should consider the efforts of the women teachers in schools and colleges providing quality education across the world. We cannot forget the contributions of the great women mathematicians like Mary Cartwright, Emmy Noether, and Sofia Kovalevskaya etc. in the field of mathematics.

Mathematicians are born with a math talent.

All great mathematicians of the world reached such heights through hard work and practice. Mathematics cannot be learnt a day or two before the exam. Only regular study can make you master the concepts.

People studying mathematics are boring and aren't creative.

The truth is that there is no math without creativity. All mathematicians discover new theorems and proofs only by using their creativity to combine different concepts and constructing something new and different.

Only intelligent people can do math or people good at math are intelligent.

Intelligence cannot be measured by one's ability to do math. Anyone can do math if he or she has interest and does regular study and practice.

People good at math must be good at doing calculations.

Mathematics is not about doing tedious calculations. It is about learning the techniques to solve and prove different formulae and concepts.

Only people with good memory can do math.

For doing mathematics you do not need to have good memorization skills. If you are well versed with the concepts then formulae can be derived whenever you need to use them. For studying mathematics you only need patience and determination to keep on trying the same question repeatedly till you find a solution.

When children are not able to solve questions or do not get correct answers they tend to fear math and refrain from it. However they should know that arriving at the correct numerical answer is not of much importance. They should focus more on logic and the procedure used for solving the question.

-Aarushi Kansal

1st Year

IN WHAT WAYS DO PROFESSIONALS USE ALGEBRA?

"Philosophy is written in that great book which ever lies before our eyes, I mean the universe, but we cannot understand it if we cannot first learn the language and symbols in which it is written. This book is written in the mathematical language, without which one wanders in vain through a dark labyrinth"

-Galileo Galilei

Algebra comes from an Arabic word al-jabr which means "the reunion of broken parts". The Greeks first introduced algebra in the 3rd century and eventually it was also traced back to the Babylonians. In the 21st century today, our society continues to leverage technology and our reliance on data continues to increase drastically. Thus we can say that the odds of living a life without algebra are becoming increasingly thin.

Do you think that the use of mathematics and algebra is only limited to professions like mathematicians, cryptologists, professors, statisticians and astronomers? Let me tell you that you are wrong!

Just like Pythagoras said : *"Number rules the Universe*", there are many unique professions that require day to day usage of algebra and that is what is called the 'beauty' of algebra. Thus, I can affirm that we need algebra to live. So, whenever you encounter someone saying "Oh, I haven't used the concept of algebra since high school", tell them how wrong they are and how they use algebra on a daily basis. To be able to do so, let us review some professions that require our algebra skills.

Animators: Math and Art go together like Ctrl+C AND Ctrl+V. Wasn't Toy Story 3 the coolest family film of the year? While watching these cute overwhelming animated movies we never think about the math. An animator uses linear algebra to show the way that an object in the movie is shifted,
made larger or smaller. All objects are modeled as small polygons and all the vertices are vectors. Linear algebra leads to required optimizations and makes it very easy for computers to perform all the necessary calculations.

Doctors: Physicians, nurses and pharmacists need a basic understanding of algebra in order to prescribe the right concentration of medication. If the prescribed medicines are more than the right

amount, the patient will not receive the benefits of the medication and if it is more than what is required then, over dosage can result in death. Algebraic equations help physicians to determine the time period in which a prescription will lose it effectiveness and require changes. Heart doctors use algebra to measure the amount of blood our heart can pump by formulating equations.

Civil Engineering: A civil engineer uses almost every form of math at one point or another. Algebra is used almost every day. A civil engineers job requires a lot of Physics. Equations in Physics which are basically algebraic equations are applied to almost all angles of an engineering problem so that the designed structures can be created the way they should be and function the way they must. Also, a civil engineer must be able to predict the cost of labor, raw materials, daily costs etc. which require concrete knowledge and a strong foundation of Algebra.

Fitness Experts and Trainers: Trainers use math and algebra while assessing their clients such as tracking measurements, calculating body fat index and waist to hip ration etc. Personal trainers use algebra and graphical knowledge in order to find out how one variable affects another, for example: Slope=Calories/Duration of exercise (in minutes)

Fitness trainers use algebraic formulas to determine the diet to exercise ratio which is probably needed in order to attain a certain goal regarding maintaining and achieving weight loss.

So, if you are a student reading this article, now is the time to think fast and never miss a thing in your next algebra class. In this increasingly tech dependent society, having a strong algebra foundation and good problem solving skills along with an analytical mind will never be a bad thing. So, o get your numbers right!

-Vanshika Singhal

1st Year

IS MATHEMATICS USED IN FORENSIC SCIENCE?

Forensic science is any branch of science which is used to analyze the crime scene of a criminal investigation and find useful evidences so that they can be acted upon by law.

The most interesting part is that all forensic science methods use concepts of mathematics and equations to reach to the evidence obtained from the crime scenes.

The Facts

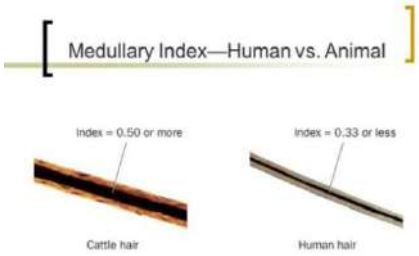
Forensic scientists need to have competence in mathematics to solve crimes and help people get justice. One of the major tasks of a crime scene investigator is to collect, measure and document evidence. This data helps forensic scientists to perform calculations and determine the facts behind a crime and reach to its conclusion. Mathematics makes it possible to show proof of what must have occurred during a crime in data and numbers.

Measurements

One area of math that is crucial to forensic science is taking precise measurements at a crime scene. Forensic scientists need exact measurements of the crime weapon, blood stains or the dead body at a crime scene in order to perform scientific calculations perfectly. Investigators spend a lot of time in measuring distance, weight, temperature, volume etc. for appropriate calculations.

Examples – Hair, is it of an Animal or a Human?

To be able to distinguish between an animal hair or a human hair, mathematicians calculate the ratio of the diameter of the Medulla (the middle, pigmented section of the hair), to the diameter of the entire hair.
Animal hair exhibits a ratio of 0.5 or higher. When the ratio is less than 0.5, then it would be considered to be that of a human.



Trigonometry

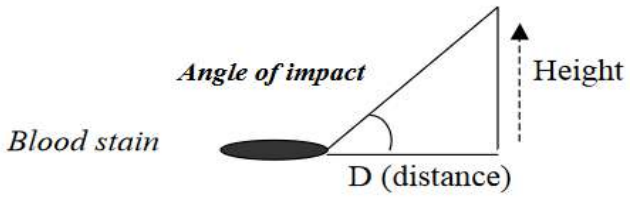
Trigonometry is another common math concept used in forensic labs. Blood spatter analysts, for example, use trigonometry in their study of how blood from a human injury splatters on a surface. Then they use the angles and distances to calculate the third point of the triangle for finding the details of the person who attacked the victim, the attacker's position, how hard he must have hit the victim and much more.

Blood Spatter Analysis

a) Determining the impact angles for each drop of blood by measuring the length and width of each droplet of blood.
b) Determining the area of convergence – by drawing the lines of convergence.
c) Once you have the point of origin, measure the distance from the origin to the blood stain.
d) Once you know the distance from the blood stain and the angle of impact, use the law of tangents to determine the height of the target. By doing this you can get an idea of the height of the criminal.

Rate of Change- Exponential Functions and Logarithmic Functions

These functions play a key role in forensics. The exponential function is used in the process where the result is dependent on the amount of material present at the crime scene at that particular time and how it changes as time changes. Rates of heating and cooling, or the metabolizing of alcohol and drugs, are governed by exponential rates of change using the Newton's Law of Cooling.



Tangent Angle = $\frac{\text{opposite}}{\text{Adjacent}} = \frac{\text{Height}}{\text{Distance}}$

Tangent Angle = Height/ distance solve for height
Height =Tangent angle/distance

This also enables us to have an estimation of the time elapsed since death. The logarithmic function allows us to compress the varied concentration of chemicals into a more manageable range. The pH scale, which indicates the level of acidity, is of this sort and is often vital in forensic labs.

Potential of Math in Forensics

Mathematics is fundamental to all kinds of science, and whether a forensic scientist specializes in biology, chemistry, computers or any other specific branch, the subject will be central to the job of solving crimes. As new scientific discoveries are constantly being made, it is possible that in future math will take on even larger roles in forensic science and forensic scientists of any discipline will need an increasingly strong educational background in the subject.

-Soumya Gulati

1st Year

A YOUNG AND DEVELOPING SCIENCE

A tool used by the players to understand the strategies of the competitors is none other than the study of mathematical models of strategic interaction between rational player decision makers. It is an umbrella term for the science of logical decision making in humans, animals and computers. It is a framework for hypothetical social situations among competing players. The key pioneers of game theory were mathematicians John Von Neumann and John Nash, as well as economist Oskar Morgenstern.

It has a wide range of applications in various fields like business, economics and politics. The key to game theory is that one player's payoff is contingent on the strategy implemented by the other player. This requires the player identities, preferences and available strategies and how these strategies affect the outcome.

Different methods are used to solve game theory which require mathematics and help in understanding the strategy of competitive players. Some important methods are minimax-maximin principle, mixed strategy or odds methods, domains method, equal game theory, graphic game theory. These methods act as a tool for game theory which helps in understanding the strategy of competitive players. These methods are divided into pure strategy and mixed strategy. To understand let's take an example of game theory solving through minimax-maximin principle. There are two players, Player A and Player B as follows:

Player A/Player B	B1	B2	
A1	9	2	2
A2	8	6	6
A3	6	4	4
	9	6	

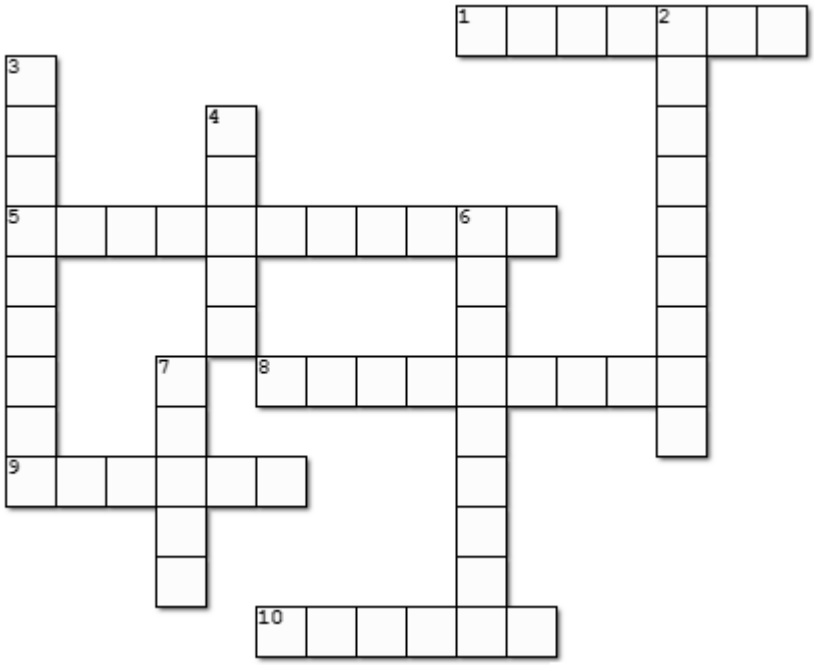
Player A will use the minimax strategy to increase its profit by choosing first minimum values then maximum value of these minimums to maximize profit. Player B will use maximin strategy to reduce its losses by choosing first maximums values then minimum of these maximums to minimize loss. For the given problem, Player A chooses 2 ,6, 4 as minimums then 6 as maximum to increase profit and Player B chooses 9, 6 as maximum then 6 as minimum to reduce loss and as a result maximum of A and minimum of B is same as 6.

So, in this way these methods act as a tool for game theory which helps in understanding the strategy of competitive players.

-Devanshi Gupta

1st Year

CROSSWORD



ACROSS		DOWN	
1.	A triangle with no congruent sides	2.	Complete the sequence: 5,7,12,19,31,50,?
5.	The chance of something happening in the future	3.	A quadrilateral plane figure having two parallel and two nonparallel sides
8.	Taxi cab number 1729 is given by	4.	A flat surface with no edges or boundaries
9.	A rectangular arrangement of numbers in rows and columns	6.	The sum of squares of two numbers is 80 and the square of difference between the two numbers is 36. Find the product of two numbers is?
10.	One cycle of a trigonometric function	7.	Month of celebration of PI day

-Riya Jain
Ex-Student, KNC
MSc. Mathematics
Amity University, Noida

A VOYAGE WITH MATHS

The journey began from one, two, three,
Gaining its pace, seeming like mystery.
With addition and subtraction as the basic steps,
Who knew division and multiplication would follow next.
The round figure of the circle and the four sided square,
Such simple shapes studied in past, are now quite rare
Then followed HCF and LCM in our life,
Which though came as a wind, is still by our side.
Profit and Loss came next in the list,
And Probability was a chapter in which we always took risk.
The sine, cos and tan in Trigonometry,
Made solving tougher, this section of Geometry.
The formulae of area and volume in Mensuration,
Were a big headache and always gave us tension.
Who knew Differentiation and Integration would come next,
Making our life full of stress.
Though Induction and Integers are hard to digest,
But if you're able to do it, you'll feel blessed.
We know Algebra is not as easy as Calculus,
However, being consistent will remove the tough topic status.
So, dear readers, don't be scared,
But work hard and Math will treat you fair.
Cause Math is fun when you start liking it,
Making you mentally healthy and fit.
So, let us make our journey with Math a happy one,
Making it full of knowledge and everlasting fun.

-Mini Melkani
1st Year

TRICK TO CRACK THE CUBE ROOT OF ANY NUMBER

<table>
<tr><td>Last digit of the perfect Cube=Possible last digit of the Cube Root = y (let)</td><td rowspan="3">Example: To find the Cube Root of 328509

Step 1: In the given number 328509, the last digit is 9, it means the cube root ends by 9. (i.e. 9 is at the ones place in the Cube Root)

For step 2, leave the last three digits aside and find the highest number whose perfect cube comes closest to it. This number will come at the tens place in the answer.

Step 2:
Leaving aside the last three digits of the number 328509, we have 328 and the highest perfect cube that comes closest to it is $6^3 = 216$.

Step 3:
So our answer is 69</td></tr>
<tr><td>Leave last three digits of the cube;
Find the number whose perfect cube comes closest to the number formed by rest of the digits = x (let)</td></tr>
<tr><td>Cube Root $= xy$</td></tr>
<tr><td colspan="2">Note: If the Cube ends with $2, 3, 7, 8$, then the Cube Root ends with $8, 7, 3$ & 2 respectively.</td></tr>
</table>

ANSWERS TO CROSSWORD

Across

1. Scalene
5. Probability
8. Ramanujan
9. Matrix
10. Period

Down

2. Eighty one
3. Trapezium
4. Plane
6. Twenty two
7. March

DEPARTMENT UNION 2018-19

L to R- Bhoomika Malhotra, Srishti Hasija, Sarvesh Kumari, Jaishree Garg, Muskan Arora, Muskaan

President	**Sarvesh Kumari**
Vice President	**Jaishree Garg**
General Secretary	**Srishti Hasija**
Treasurer	**Muskan Arora**
Media Coordinator	**Muskaan**
Media Coordinator	**Bhoomika Malhotra**

"The strength of the team is each individual member. The strength of each member is the team."

BATCH 2016-2019

First Row(L-R): Mr. Pushpendra Kumar Vashishtha, Dr. Shailendra Kumar Bharati, Ms. Divya Saigal, Dr. Pragati Gautam, Ms. Saroj Gupta, Dr. Pooja, Ms. Swapnil Verma, Dr. Mohammad Mueenul Hasnain

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Third Row(L-R): Akanksha, Ritika Khanna, Tamanna Yadav, Kajal Gautam, Pooja, Srishti Hasija, Sarvesh Kumari, Nisha Sharma, Nayana Tyagi, Shivani, Karuna Panchal

Fourth Row(L-R): Rachika Bharti, Raksha Gupta, Shahana Parveen, Jyoti Kumari, Chanchal Kumari, Sandhya Rao, Jigyasa Ahuja, Harshita

"Each human being, however small or weak, has something to bring to humanity."

-Jean Vanier