AXIOM'17

VOLUME - 6

NEWSLETTER

DEPARTMENT OF MATHEMATICS

KAMALA NEHRU COLLEGE, UNIVERSITY OF DELHI

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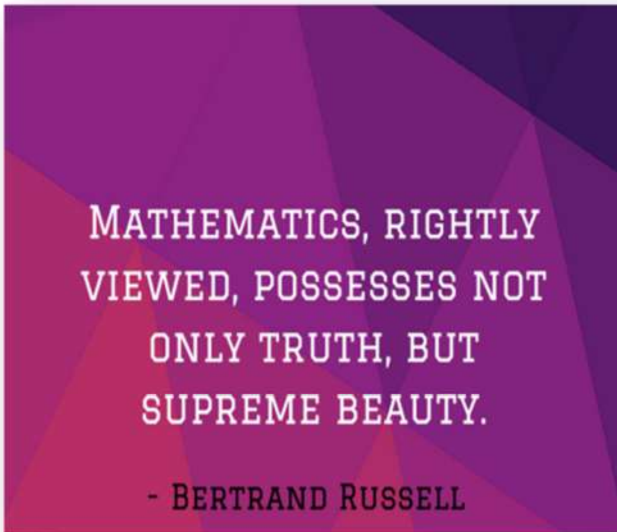
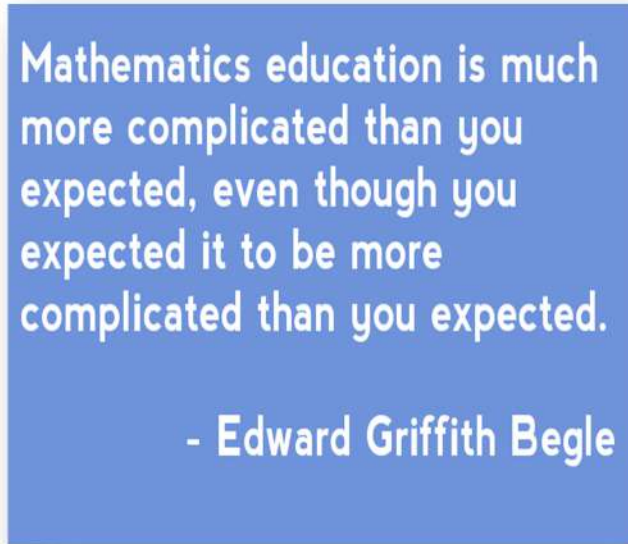
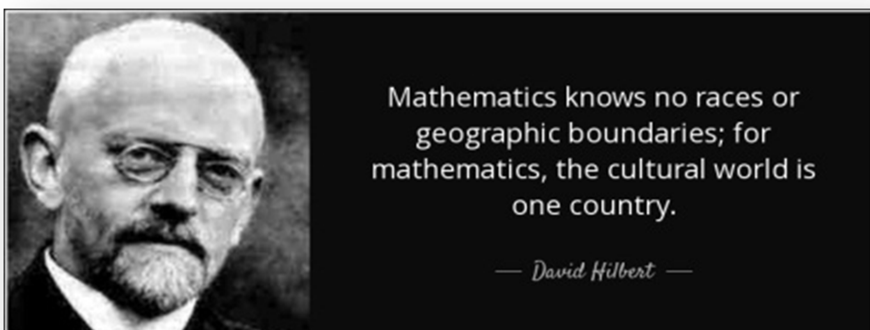
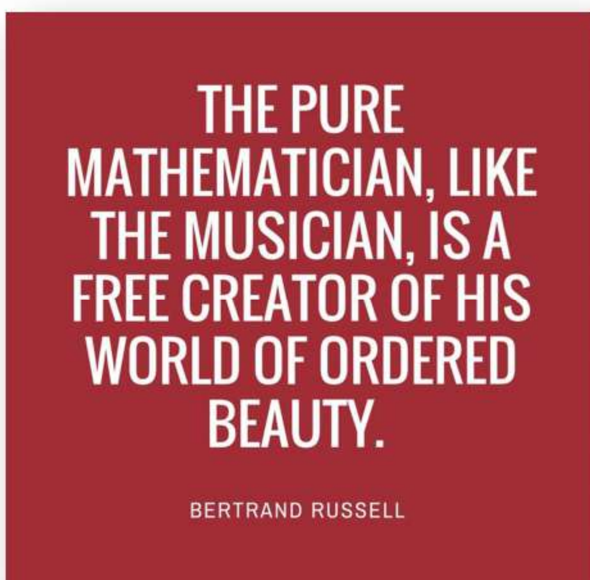

MATHEMATICS, RIGHTLY VIEWED, POSSESSES NOT ONLY TRUTH, BUT SUPREME BEAUTY.
- BERTRAND RUSSELL


Mathematics education is much more complicated than you expected, even though you expected it to be more complicated than you expected.
- Edward Griffith Begle


Mathematics knows no races or geographic boundaries; for mathematics, the cultural world is one country.
— David Hilbert —


THE PURE MATHEMATICIAN, LIKE THE MUSICIAN, IS A FREE CREATOR OF HIS WORLD OF ORDERED BEAUTY.
BERTRAND RUSSELL

FROM PRINCIPAL'S DESK

A living being is a unity. It is much simpler to view it as a whole than as the sum of parts. All the atoms in it cooperate and work together. If someone is afraid of missing the bus to his office, all his incredibly many molecules, his organs, his cells, will be cooperating so that he finishes breakfast quickly and runs to the station.

In mathematical terms, if we want to compute a complete description of a living being, the program will be smaller in size if the calculation is done all together, than if it is done independently by calculating descriptions of parts of the person, and then putting them together. The case is the whole versus the sum of its parts.

We all must learn from this law of unity, and work together to evolve in our lives as a whole, as a humanity, rather than sum of people.

My best wishes to the Mathematics department, specially the editorial team, for bringing out this newsletter as their annual publication.

Dr. Kalpana Bhakuni
Principal

Kamala Nehru College
University Of Delhi

MAGIC IN TAXICAB NUMBER

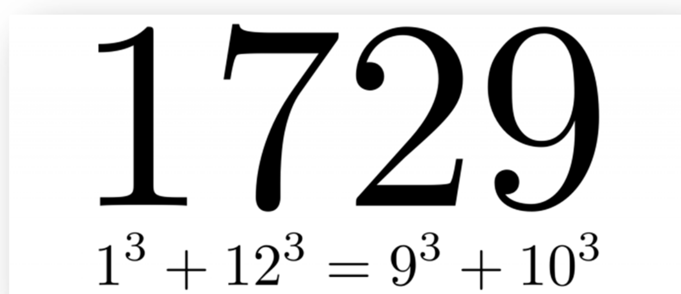
When you love mathematics you can see magic in numbers. Your face lights up when you observe something new about a number. Something similar and very interesting happened with the great Indian mathematician SrinivasaIyengar Ramanujan.

The Ramanujan number is 1729 which is also known as the Hardy-Ramanujan number. There is a famous anecdote behind this name. It is about British mathematician G.H.Hardy's hospital visit to meet an ailing Ramanujan.
Hardy went to see him when he was ill at Putney. He had ridden in taxicab number - 1729 on his way to the hospital and remarked that the number seemed quite dull to him. Hardy further said that he hoped this dull number wasn't some kind bad omen. Ramanujan refuted Hardy's claim and stated that 1729 is in fact a very interesting number-It is the smallest number expressible as the sum of two positive cubes in two different ways.

The number is such that,

$$\mathbf{1729 = 1^3 + 12^3 = 9^3 + 10^3}$$

In this way, Ramanujan made a dull taxicab number interesting. Till date only 10 taxicab numbe rs are known .Subsequent taxicab numbers are found using computers.



-By
SAVITA
3rd YEAR

Who says 'nothing is perfect’?

We heard them say, “Nothing is perfect”. Well, there are two things in this world that are perfect. One is Mother Nature, the other is mathematics. When I say perfect, I mean it cannot get better than this.

How can it be concluded? Mother Nature is a complex web of life and the lifeless. The very state of it being so perfect is the reason for life and also for death. Mathematics, on the other hand, is man-made, to understand nature and beyond. Now, there is a debate over whether mathematics was invented or discovered, but either way it is still perfect.

Math is founded on simple yet powerful elements — numbers. Numbers, just like the elements of nature, share a complex relationship with every other element in that set.

This relationship is universally valid. The equation, $a^2 + b^2 + 2ab = (a + b)^2$, stands true on Earth, on Jupiter and even if the sun goes down because math doesn’t exist in any physical dimension. Rather, it exists entirely in the human mind. It is a mental concept. Mathematics and human beings are co-dependent and aid each other’s growth.

When we get to the bottom of it, we see that math is an abstract representation of nature — element to element, shape to shape and relation to relation. This fundamental reason suggests that mathematics is no different from nature. Hence, any real-world problem can be solved in mathematics

What is the largest number your mind can conceive? What is the size of the universe?
The answer to both these questions is one and the same. The answer is not infinity, it is zero.
For every positive number there exists a negative number in mathematics. For every matter there exists anti-matter in nature. Therefore when you put everything together, the size of the universe is zero. Zero is thus simultaneously everything as well as nothing. That’s why it’s called a whole number.

This beautiful conception was made in ancient India at a time when the rest of the world was busy figuring out whether the earth is flat or round. It’s really astonishing and makes me proud of the intellectual wisdom of ancient India, making such a ground-breaking revelation that changed the human thought process once and for all!

-By
SHIVANGI SHARMA
2nd YEAR

The Multistep Friendship Paradox

The Friendship Paradox, proved by sociologist Scott L. Feld in 1991, states that on an average, your friends have more friends than you do. It can be explained as a form of sampling bias in which people with more friends have an increased likelihood of being observed among one's own friends. In fact, Feld proved two versions of paradox.

In spite of its apparently paradoxical nature, the phenomenon is real, and can be explained as a consequence of the general mathematical properties of social networks. The mathematics behind this are directly related to the inequality of arithmetic and geometric means and the Cauchy Schwarz inequality.

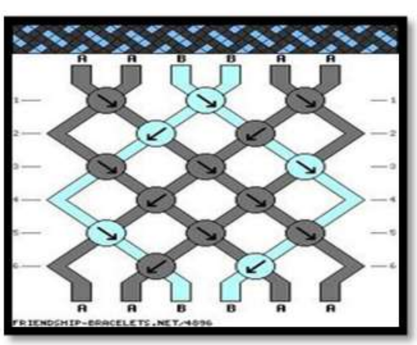
Mathematically, Feld assumes that a social network is represented by an undirected graph **G = (V, E)** where the set **V** of vertices corresponds to the people in the social network, and the set **E** of edges corresponds to the friendship relation between pairs of people. That is, he assumes that friendship is a symmetric relation: if **X** is a friend of **Y**, then **Y** is a friend of **X**. He models the average number of friends of a person in the social network as the average of the degrees of the vertices in the graph. That is, if vertex **v** has **d(v)** edges touching it (representing a person who has d(v) friends), then the average number **μ** of the number of friends of a random person in the graph is

$$\boldsymbol{\mu} = \frac{\sum_{v \in V} d(v)}{|V|} = \frac{2|E|}{|V|}$$

The average number of friends that a typical friend has can be modeled by choosing uniformly and at random an edge of the graph (representing a pair of friends),an endpoint of that edge (one of the friends), and again calculating the degree of the selected end point, that is

$$\frac{\sum_{v \in V} d(v)^2}{2|E|} = \boldsymbol{\mu} + \frac{\sigma^2}{\mu}$$

Where $\boldsymbol{\sigma^2}$ is the variance of the degrees in the graph. For a graph that has vertices of varying degrees, both $\boldsymbol{\sigma^2}$ and $\boldsymbol{\mu}$ are positive which implies that the average degree of a friend is strictly greater than the average degree of a random node.



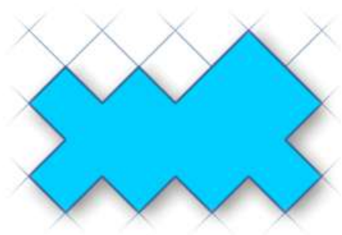
Application: A study in 2010 by Fowler showed that flu outbreaks can be detected by utilizing the friendship paradox in monitoring the infection in a social network almost two weeks before traditional surveillance measures can detect them. They found that using the friendship paradox to analyze the health of central friends is " an ideal way to predict outbreaks."

-By
RIYA JAIN
2nd YEAR

Puzzles to Puzzle You

Can you solve Martin Gardner's best mathematical puzzles?

The maestro of recreational mathematics was born 103 years ago. Here are some of his most celebrated puzzles.



1. Crazy cut

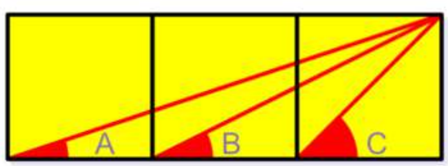
You are to make one cut (or draw one line) – of course it needn't be straight – that will divide the figure into two identical parts.

2. The coloured socks

Ten red socks and ten blue socks are all mixed up in a dresser drawer. The 20 socks are exactly alike except for their colour. The room is in pitch darkness and you want two matching socks. What is the smallest number of socks you must take out of the drawer in order to be certain that you have a pair that match?

3. Cutting the pie

With one straight cut you can slice a pie into two pieces. A second cut that crosses the first one will produce four pieces, and a third cut can produce as many as seven pieces. What is the largest number of pieces that you can get with six straight cuts?



4. Three squares

Using only elementary geometry (not even trigonometry), prove that angle C equals the sum of angles A and B.

5. The two spirals

One of these spirals is formed with a single piece of rope that has its ends joined. The other

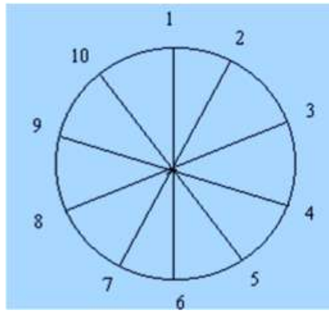
spiral is formed with two separate pieces of rope, each with joined ends.

Can you tell which is which by using only your eyes? No fair tracing the lines with a pencil.

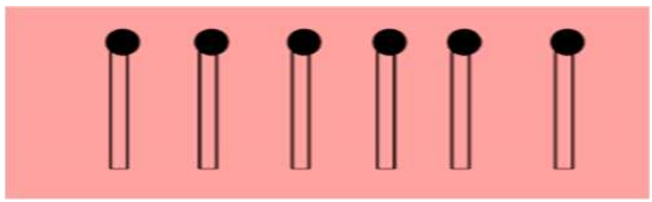
-By
PARTHVI BHUTANI
2nd YEAR

6. Here is a sketch:

Can you rearrange the position of the numbers 1 to 10 so that sum of any two adjacent numbers is equal to sum of the pair of numbers at the opposite ends of the diameters?



7. Shown in the sketch are six matchsticks. Can you rearrange them to make nothing?



-By
MARMIKA
3rd YEAR

Answers given on Page No. 16

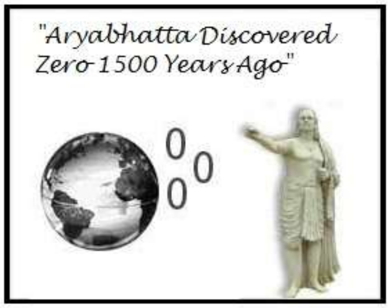
SOME INTERESTING TYPE OF NUMBERS

CIRCULAR PRIMES: A circular prime number is one that remains a prime number after repeatedly relocating the first digit of the number to the end of the number. For example: 197,971 and 719; 1193, 1931, 9311 and 3119 are all prime numbers.

APOCALYPSE NUMBER: The apocalypse number, 666, often referred to as the beast number, is referred to in the bible. The number has some surprisingly interesting characteristics. It is the sum of the first 36th triangular number. The sum of the squares of the first 7 prime numbers is 666.

$$1^3 + 2^3 + 3^3 + 4^3 + 5^3 + 6^3 + 5^3 + 4^3 + 3^3 + 2^3 + 1^3 = 666$$

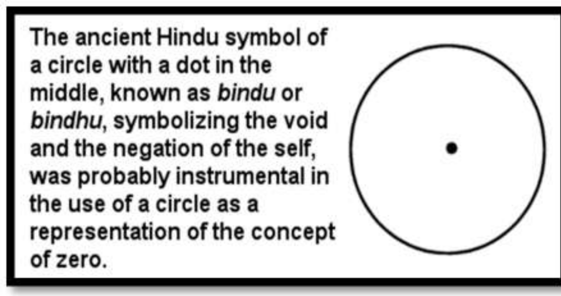
ZERO



Once upon a number
That lived within a field
It was the only number
Present in both ideals

Endlessly unchanging
When doubled; yet, in fact-
When added to the other thing
The other stayed intact

So unique, this number,
Was left out of the loop-
It could not be a member
Of the multiplicative group



And yet, in categories,
It often had a place...
But can't be pointed to be any
Map, in any case!

Preserved by every morphism,
Destroyed by every pole-
In certain complex manifolds
It's nothing but a hole...

Amidst these wild properties
It lives, and still exists-
For no other identities
Are additive as this

By-
SHIVANI
2nd YEAR

GEOMETRY IN FASHION

Fashion is one of the most inventive and creative platforms for any designer. Regardless of what a person is designing, designs are based on geometry with the use of shapes, angles, lines and more!

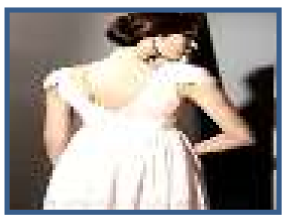
Shapes in Fashion: Geometrical designs serve to add an intricate amount of details to an otherwise ordinary outfit.

The designs of wedges and dresses use various triangles, rhombuses and circles to form an interesting and creative pattern. Without the geometric shapes these wedges and dresses would be very simple and ordinary.

More about geometry and constructing garments:

When designing shirts and pants, the designer must ensure that the seams are parallel in order for shirt to hang correctly on the body. If seams aren't parallel, then the shirt will not fit properly.

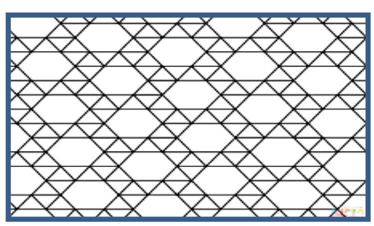
Right angles are very important in fashion design and in constructing a garment. If a right angle is not formed then the pants will be uneven. Another example of angles in the construction of clothing is V-neck. With a V-neck, the neckline must be about a 90 degree angle.

Shapes and Lines in Designs: Designers use various shapes and lines to create patterns that we see in everyday life.

For example: Plato's collection was inspired by the five platonic shapes: tetrahedron, cube, octahedron, dodecahedron and icosahedrons. Plaid, Argyle, Tessellation and many more patterns are based on geometric arrangements of shapes and lines.

Plaids



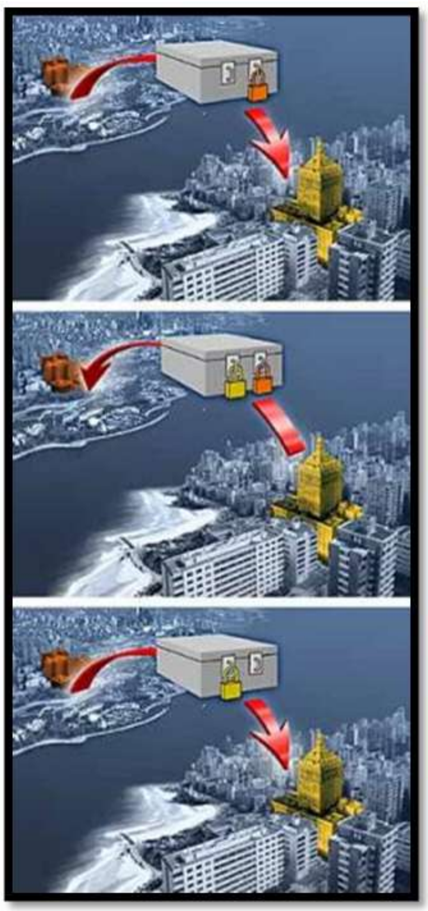
Tessellation

Argyle

By-
POOJA KUMARI
2nd YEAR

CRYPTOGRAPHY IN THE PROBLEM OF KEY DISTRIBUTION

Encryption, codes and ciphers were once associated only with spies, espionage and illicit letters between lovers. But cryptography - the science of secrecy - is now a part of our everyday lives, and we use it whenever we send an e-mail or shop online. It is the mathematics behind cryptography that has enabled the e-commerce revolution and information age.



Key distribution

More recently, mathematics has provided the solution to the *Key Distribution Problem* which has been one of the biggest problems in cryptography for over 2,000 years.

But thankfully, mathematicians hadn't given up in all these years. "The great thing about mathematics is that something might look impossible, but unless somebody has proved it mathematicians say 'well, let's try and find a solution.'" And that is just what they did.

SOLUITON

"I put a message in a box; I close the lid, turn the key and send it to you. But you can't open it because I've still got the key. Some mathematicians, Diffie, Hellman and Merkle thought of another way to think about it.

"How about I put the message in the box, I close the lid and I *padlock* it and then send it to you. Now you still can't open it. What you do is you put *your* padlock on it and send it back to me. Then I take my padlock off, send it back to you. You take your padlock off and you open the box."

So theoretically a message could be communicated secretly without ever exchanging a key.

BY-
DIVYA BABBAR
2nd YEAR

MATH-E-MELANGE

A language that knows no bounds
One that makes the minds go round
Which entails scratching of grey cells
That can instill the feeling of turbulence

Some associate it with dread
While some as a desperate need
A cauldron brimming full of puzzle
Where everything looks like an engrossing thing to juggle

Solution is the sole thing to chase
Whilst moving on a flash spirit's pace
Numerical acumen is the thing to imbibe
To bask in the glory of mathematical vibe

By-
KRITIKA NARULA
2nd YEAR

MATH MANIACS

We live in a mathematical vibe
And we find it an extricate ride
This analytical world looks so sheen
Logic is the sole thing to feed

This Pandora box of mathematical tools
Acts as an unbeatable confidence boost
Grateful to the mathematical grace
That it makes the problems fade

We have a knack for numbers
Finding peace on grabbing solutions
This numerical world is a blessed odyssey
And we truly acknowledge its credibility

By-
LEENA BATRA
2nd YEAR

RHYTHM OF LIFE AND MATHEMATICS

Each one is unique like identity
Their never ending desires tends to infinity
But the resources to meet them are finite
And calculations in my mind start to ignite

Add your adventures and store memories
Subtract your hatred, anger and egos
Multiply your joys and happiness
Divide your time in better things
Then see the resultant, satisfaction is yours

Your journey is like oscillatory sequence
Sometimes you succeed and sometimes you collapse
Sometimes situations are favorable and sometimes adverse
But be continuous and never recede
Then certainly you will succeed

Parents are that circle which protects us from evils
Teachers are those functions which provides us knowledge
Friends are the operators which differentiate our sorrows
Though, as individuals we all are discrete
But this small world makes us complete

People transform with time like linear transformation
Stay with positive, they will give you motivation
Delete negatives, otherwise you will end up in isolation
These small steps will lead you in the right direction

Shadows of the past like faded shapes
Equations of the present like parallel lines
Conditions of the future like imaginary numbers
Reflects on people’s expressions like sine and cosines

There are many variables influencing our life
Analyze every step and be precise
As one wrong move can change your entire life
So, live it like a dream not just survive

By-
JYOTI
3rd YEAR

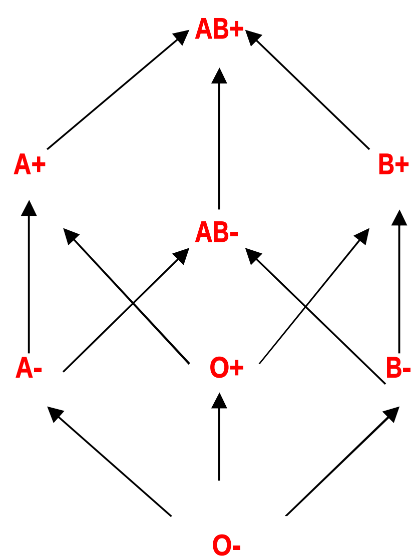
Mathematics in our Blood

Mathematics expresses itself everywhere and in every facet of life- in nature all around us and in the technology in our hands. Let us take the example of the human body and its working. Every part of human body consists of some hidden concepts of mathematics. Take for example the flow of blood inside the body. This flow is a continuous function or more precisely a periodic function. A set of blood groups of human beings forms a 'partial ordered set'. We all know there are 8 different kind of blood groups { 0+,0-,A-,A+,B-,B+,AB-,AB+}. Hasse diagrams would be a great way to explain the donation relationships between blood types. A Hasse diagram visually depicts the relationships of a partially ordered set. A partially ordered set is just a set of things and a transitive relationship. In this set, relation is defined only when 1st person can donate blood to 2nd person. 0- is universal donor, therefore 0- can donate blood to all and AB+ is universal receiver, therefore AB+ can take blood from all as we can see by partial ordered set.

So, here we can form the relation in this way:

{(0-,0-), (0-,0+),(0-,A-), (0-,A+),(0-,B-),(0-,B+),(0-,AB-),(0-,AB+),(0+,0+),(0+,A+),(0+,B+),(0+,AB+),(A-,A-),(A-,A+) ,(A-,AB-), (A-,AB+),(A+,A+),(A+,AB+),(B-,B-),(B-,B+),(B-,AB-),(B-,AB+),(B+,B+),(B+,AB+),(AB-,AB-), (AB-,AB+), (AB+,AB+)}

Blood donation can be seen mathematically using this Hasse diagram:



By-
KOMAL NEGI
3rd YEAR

MATHEMAGICIAN

The mathematician
is indeed a magician
for he plays with numbers
like they were some kind
of juggle balls.

He speaks the language of the universe,
the language of logic;
Speaking in analogies
he combines equations
like the chemist combines toxic elements ...

Equations
-they are the words
of logical thought,
are capable to tell stories
about the universe's very first day.

The mathemagician's passion
is to find analogies
between analogies,
just like writer
searches for metaphors...

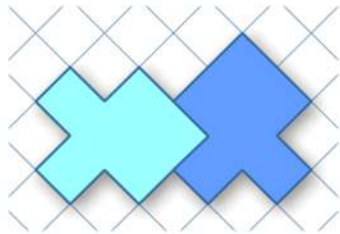
He searches for understanding cosmos...
In dialogue with universe
he begins to wonder and wander
across the ocean of infinite possibilities.

Fervour with measures,
passion with exactness,
that's the ultimate of mathematics;
Connecting the details
to create the big puzzle.

By-
SUSHMA YADAV
3rd YEAR

Answer to the Puzzles

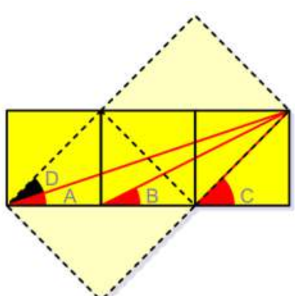
1. Crazy cut -The hint wasn't a red herring. The line isn't straight



2. The coloured socks -Solution: Three socks. With two socks it is possible to have one red and one blue. But with three there is always a matching pair since either you will have chosen three of the same colour, or a matching pair and an odd one out.

3. Cutting the pie -Solution: You can do this by trial and error, but the sketch will get a bit messy, and it is not particularly insightful. Better to think up a rule. So, think about what is happening when you add straight cuts. The first cut splits the pie into 2 pieces. The second cut makes 2 more pieces, bringing the total to 4. The third cut makes 3 more pieces, bringing the total to 7.It looks like each cut adds the total number of pieces by the number of the cut – and with a little more thought we can see why this is true. So, the fourth cut will make as many as 4 new pieces, the fifth cut 5 and the sixth cut 6. The largest number of pieces therefore is 22.

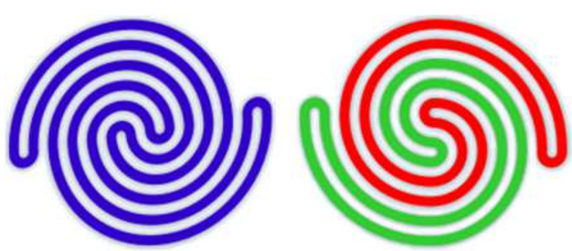
4. Three squares Solution: Here's one way to do it.



Construct the additional squares indicated by dotted lines. Angle C is the same as the sum of angles A and D, since they are both made by cutting a square in half along the diagonal. Angle B equals angle D because they are corresponding angles of similar right triangles (made by cutting a rectangle made from two squares in half along the diagonal). That means B can be substituted for D, which automatically makes the C equals the sum of A and B.

5. The two spirals

The spiral on the left is the single rope



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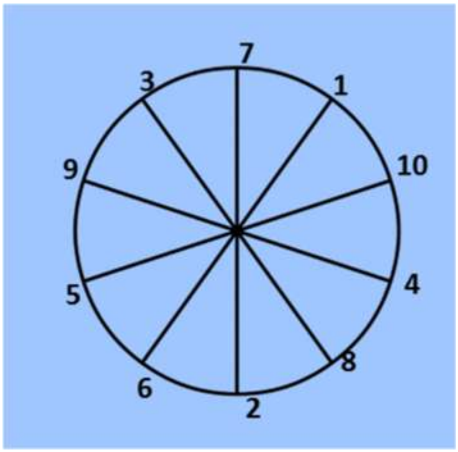

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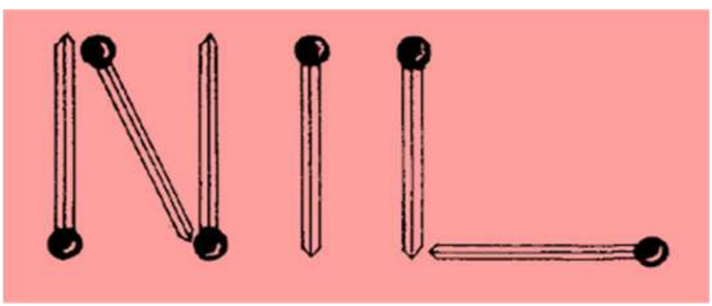
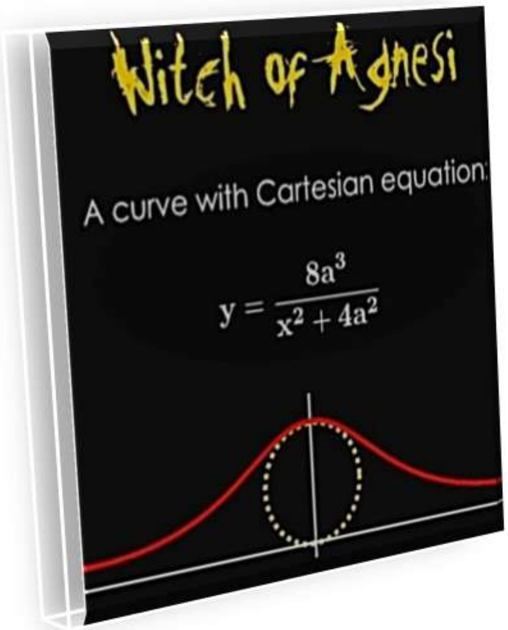
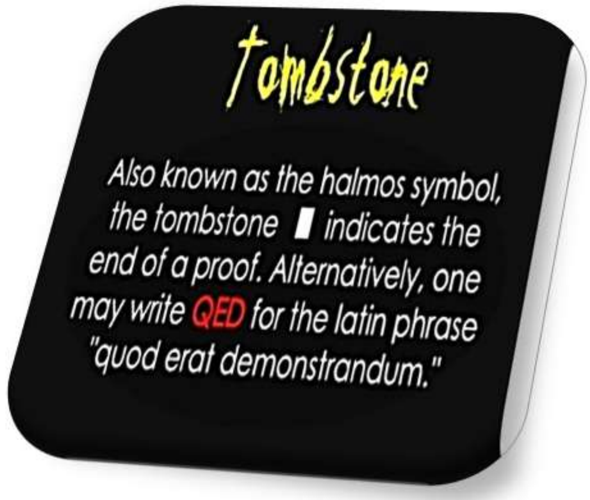
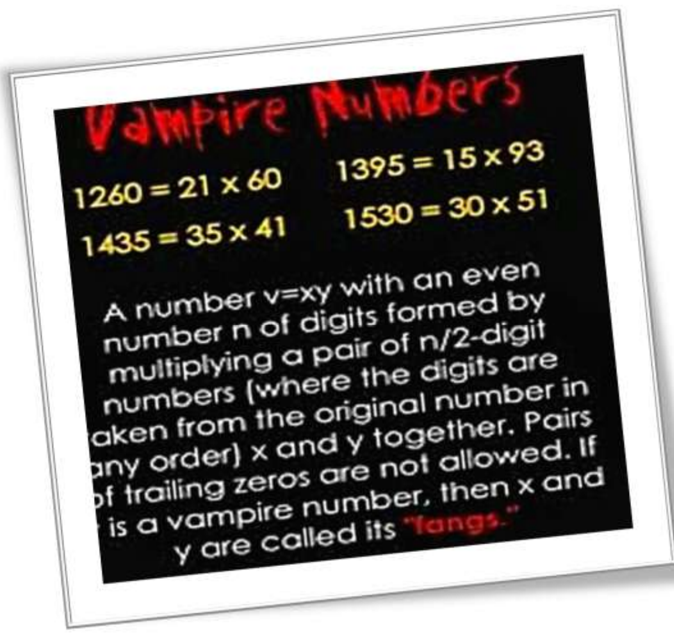
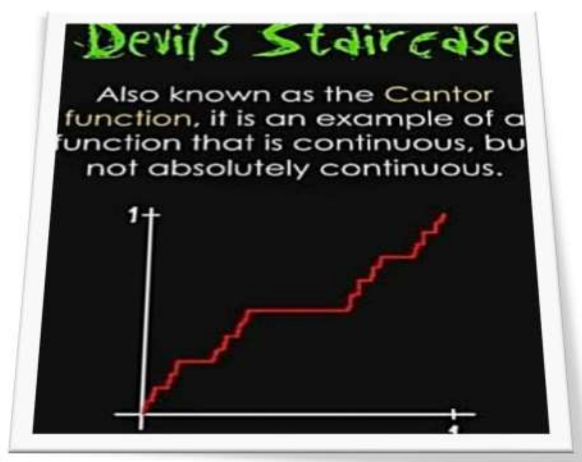


VICIOUS MATHEMATICS









-BY
AAKRITI HANS
2nd YEAR

A Study of Stochastic Programming Problems

Project entitled " A Study of Stochastic Programming Problems "is the study of random variables and their various kinds, probability distribution function, probability mass function, probability density functions and different types, expectation of random variables, fuzzy sets, fuzzy numbers, triangular fuzzy numbers, alpha cuts its properties, Zadeh extension principle, linear programming problems.

In present work, we have proposed a computation method for the solution of stochastic linear programming based fuzzy sets. We had also used an example to illustrate our method.

Project Supervisor: S. K. Bharati
Submitted by:
Kritika Goyal and Saumya Agarwal
B.Sc. (Hons) Maths Sem-2 (2015-2016)

Fuzzy Sets and Its Applications

Project entitled "Fuzzy Sets and Its Applications "is the study of fuzzy sets and its various set theoretic operations, arithmetic operations, fuzzy numbers, triangular fuzzy numbers, alpha cuts and its properties, Zadeh extension principle, it's application in linear programming problems.

Conventional optimization methods used exact values of parameters assigned by experts or statisticians for dealing with real life problems particularly in the areas of management, planning, economics etc. Experts do not know complete information about values of parameters involved in mathematical models of realistic problems. Thus conventional tools have failed to deal with such problems due to the uncertainty involved in information about values of the parameters. Zadeh introduced the concept of fuzzy sets for dealing with real life problems.

Present project contains historical introductions of linear programming problems and fuzzy sets, some definitions and principles are given in preliminaries related to our project. Further, we have studied fuzzy linear programming problems. We have also illustrated the fuzzy linear programming problems.

Project Supervisor: S. K. Bharati
Submitted by:
Riya Jain, Somya Mittal and Aastha Chaudhary
B.Sc. (Hons) Maths Sem-2 (2015-2016)

GOLDEN MEAN AND ITS APPLICATIONS

The presentation on "Golden Mean and its application" was an attempt to discuss the various unique mathematical properties of The Golden Ratio and its applications. It is the only positive number whose square is one greater than itself. It is the only positive number whose reciprocal is one less than itself. These properties make it unique along with wide ranging application. What makes golden mean unusual is that it can be derived in many ways mathematically and geometrically and shows up in relationships throughout the universe. Golden mean appears in the proportions of the human body and face, the proportions of many other animals, plants, DNA, the solar system, population growth the stock market and in many aspects of life and the universe. Our perceptions of beauty in the humans are based on how close facial proportions conform to golden mean. Our research work has shown that if we look closely then the Golden ratio is present everywhere.

Project Supervisor: Nasheem Khan
Submitted by:
Aakriti Hans and Parthvi Bhutani
B.Sc. (Hons) Maths Sem-2 (2015-2016)
Jyoti and Komal Negi
B.Sc. (Hons) Maths Sem-4 (2015-2016)

APPLICATIONS OF PARTIAL DERIVATIVES IN ECONOMICS

Economics is the branch of knowledge concerned with the production and consumption of goods and transfer of wealth. It is not at all surprising to know that mathematics helps us in dealing with other disciplines. So, it is a wonderful idea to link mathematics with economics to make it easier and more interesting. There are numerous applications of partial derivatives in various fields of economics. We can apply the method of solving partial derivatives to find the marginal products of labor and capital, marginal utilities, and elasticity of demand. We can also use partial differentiation to plot the indifference curves.

Clearly the use of partial derivations can help in making conclusions and derivations in economics easy and there is great future scope of the use of partial derivatives in economics.

Project Supervisor: Dr. Pooja
Submitted by:
Leena Batra, Vishakha Goel, Meghna Shrivastava, Kritika Narula and Shikha Yadav
B.Sc. (Hons) Maths Sem-3 (2016-2017)

LEVEL CURVES AND SURFACES

As the name of the title suggests, Level Curves is an application of Multivariate Calculus. We began our project describing contour maps and curves (also called level curves) and their graphical interpretation along with mathematical formulas. The main highlight was the importance of slope and gradient in Geosciences which play an important role in determining the amount of erosion likely during a rainstorm and the measure of steepness or the degree of inclination of a feature relative to the horizontal plane (land). We also described the concept of directional derivative which is useful for finding the rate of height change along any path. In addition to it our project has practical meaning of Level Curves using Computer Algebraic Systems (Mathematica and Maxima) and their use in calculation of Critical Points and Saddle Points.

Project Supervisor: Dr. Pooja
Submitted by:
Aakriti Hans, Aastha Chaudhary, Nikita Kaushik, Parthvi Bhutani, Riya Jain and Shelly Sharma
B.Sc. (Hons) Maths Sem-3 (2016-2017)

Real life Applications of Calculus

The Project entitled **"Real Life Applications of Calculus"** is a study of the applications of Calculus in various fields. There are many real world applications of calculus from sports to engineering to astronomy and space travel. In physics, calculus is used in a lot of its concepts. Physical concepts that use concepts of calculus include motion, electricity, heat, light, harmonics, acoustics, astronomy, and dynamics. Even the advanced physics concepts of electromagnetism and Einstein's theory of relativity use calculus. In the field of chemistry, calculus can be used to predict functions such as reaction rates and radioactive decay. In biology, it is utilized to formulate rates such as birth and death rates. In economics, calculus is used to compute marginal cost and marginal revenue, enabling economists to predict maximum profit in a specific setting. In addition, it is used to check answers in different mathematical disciplines such as statistics, analytical geometry, and algebra.
Present project contains introduction to various topics of calculus and their application in other fields as well as day to day activities.

Project Supervisor: Pragati Gautam
Submitted by:
Saumya Agarwal, Komal Negi, Jyoti and Sushma
B.Sc. (Hons) Maths 3rd Year (2016-2017)

TO WITNESS THE VARIANT HUES MATHEMATICS IS THE ULTIMATE DESTINATION TO CHOOSE.

Mathematics is not about numbers, equations, computations or algorithms: it's about understanding

- Kritika Goyal (3rd year)

These three years of my graduation in KNC has enhanced my mental horizon towards innovative thinking and encouraged me to move further with new ideas and thoughts. KNC has provided me a platform where I can enrich myself in a global, multicultural and multidisciplinary environment.

- Km. Payal (3rd Year)

Sometimes all it takes is a little determination, a pen and some paper for the problem to become a solution.

- Nupur Upadhyaya (3rd Year)

BATCH OF 2014-17

FIRST ROW(L-R) – *Shobhana Thakur, Megha Berlia, Arpita Sagar, Swetcha Ganapati, Manpreet Kaur, Divya Bhatia, Monika Bist*

SECOND ROW(L-R) – *JigyasaTiwari, Savita Saini, Sushma Yadav, Pratibha, Upasana Rajpoot, Komal Negi, Mona Kumari, Anjul Katiyar, Jyoti*

THIRD ROW(L-R) – *Himani Saini, Parul Dahiya, Mohini Gohri, Garima Joshi, Vaishali Jain, Hiteshi Clare, Chahat Mehendiratta, Payal, Monika*

FOURTH ROW(L-R) –*Nupur Upadhyaya, Saumya Agarwal, Vandana Goel, Marmika Singh, Akanksha Gautam, Kritika Goyal, Pooja Kumari, Sakshi Solanki*

FIFTH ROW(L-R) – *Mr.Shailendra, Mr.Nasheem, Ms.Pragati, Ms.Saroj, Dr.Pooja, Ms.Anuradha, Ms.Deepshikha*