# ANANTYA

## ...Beyond Infinity


DEPARTMENT OF MATHEMATICS
MATA SUNDRI COLLEGE FOR WOMEN
(UNIVERSITY OF DELHI)

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50TH YEAR GOLDEN JUBILEE EDITION

# MATA SUNDRI JI

Mata Sundri ji was the daughter of Bhai Ram Saran, a Kumarav Khatri of Bijvara, in present-day Hoshiarpur district of the Punjab. She was married to Guru Gobind Singh ji at Anandpur on 4 April 1684. After the death of Guru Gobind Singh ji, for the remaining 40 years of her life, Mata Sundri ji took up all the tasks that had been initiated by the Guru and established herself as a capable successor and leader of the *Panth.*

Mata Sundri Ji had compiled the works and writings of the tenth Guru, entitled *Vidya Sagar.* This valuable piece of work had been lost in the flooded Sirsa river during the march from Anandpur. Under the supervision of Mata Sundri, Bhai Mani Singh undertook the task of collecting these pieces and compiled them into one volume, as the *Dasam Granth.* Mata Sundri ji persuaded the devout Sikhs to prepare copies of the holy hymns of the Great Adi Granth Sahib.

Mata Sundri ji had her whole energy devoted to building up the *Panth* and keeping it united. She was a woman of strong principles and adhered to a strict code of conduct. She was regarded as a worthy representative to the great Guru and had advocated fearlessness with the words:

*Bhei knhu ko det neh,*

*Nehn bhei manat aan.*

(Do no frighten anybody, neither be afraid of anybody.)

Mata Sundri ji is the epitome of selflessness and austerity. She will always shine like a star and guide the people to the right path. We bow our heads as a mark of respect before the greatness of her soul.

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**RESOURCES** :


- https://www.allaboutsikhs.com/great-sikh-women/mata-Sundri-ji
- http://www.searchsikhism.com/mata-Sundri-a-multi-faceted-personality

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## PRINCIPAL'S DESK

I extend my warmest wishes to the department of Mathematics for coming up with the inaugural edition of their e-magazine, 'Anantya: Beyond Infinity'. It is indeed enchanting that on the occasion of the golden jubilee year celebrations of Mata Sundri College for Women, the department has taken up this initiative to showcase the diversity of mathematics in a very intriguing way.

Anantya has given a platform to the students and the faculty to express their thoughts freely and let everybody know their true potential. It is a commendable effort so as to develop valuable skills in the students and for them to become more confident in putting their opinions on the front. I would also like to thank our qualified and experienced teachers and the sincere students who have made our events and endeavours possible. This magazine is a compilation of the academic and the extra-curricular achievements of the department. It is a stage to show the laurels brought by the students to the college.

The work done by the editorial team is admirable. I wish the publication and its associates' all the luck and grand success.

Dr. Kawarjit Kaur
(Officiating Principal)

## FROM THE EDITORS' DESK

When it comes to learning, we live in incredible times; all the knowledge of the world is just a click away. We can quench the thirst of our curiosity in seconds with a few taps on our cell phones. Technology has revolutionised our ability to learn by providing information on demand. Mathematics, being one of the most brain storming fields for the people to work on has also had its share of lead in today's contemporary world. Technology and mathematics are moving hand in hand these days.

Here at Mata Sundri College for Women, we have been making a consistent effort to walk with the same pace as the rest of the world. Inculcating the qualities such as strong work ethics, resilience, communication as well as balance. Providing equal chances for the students to grow while building productive relationship with their fellows as well as the faculty is precedence here. To become purpose driven and to develop a mindset for success is being taught everywhere but what makes MSC different is that its values are deep rooted. Along with the advanced outlook and the latest technology its ambience enlightens everybody. Enlightenment does not merely mean spiritual awakening but to understand the purpose of us being a human and act accordingly is the true meaning of it.

The department of mathematics in particular has been very active throughout these years in order to make the process of learning more interactive as it has been enthusiastically organising numerous competitions, sessions etc to boost up the confidence of the students. Rather than sticking to only mathematics, the department has been quite unconventional in terms of the brushing up that it gives to the students. Keeping in mind the versatility of students and understanding the fact that different people have different interests and capabilities. Thus providing the students with an adaptive learning medium. The resourceful and yet so frank faculty makes an integral part of the system which has been successfully shaping the bright future of the students ever since the establishment of the college.

We hope that the process goes on and on as it is a journey that is never ending – the one which evolves with us as we pass through the many stages of life. Just as outer space is mysterious and unlimited, so is the world of mathematics. And the best part is you don't need a rocket ship to explore it!

Deeksha Aashri
Kamna Mamgain

## DEPARTMENT OF MATHEMATICS

## EVOLUTION @ MSC

### From the Desk of Teacher In-charge

From its inception in 1967 with strength of only 5 students in the discipline of Mathematics to the present strength of 167 students, the Department of Mathematics has developed and grown in several directions. It is our endeavour to provide an in-depth knowledge and understanding of the fundamental concepts of the subject whereby students learn to think logically and critically, develop problem solving ability, apply mathematical concepts and reasoning effectively, are encouraged to pursue challenges of research and become lifelong learners.

To commemorate the 50th Year Celebration of our College the work of inauguration of our e-magzine - **'Anantya: Beyond Infinity'** by combined efforts of our Departmental Society - `ASYMPTOTE' and Faculty Members of Department is commendable and praiseworthy. - This e-magzine is instrumental in providing both an intellectually and creatively stimulating environment to the students and aims to encourage greater participation at all levels. We believe fundamental philosophy is not limited to produce skilful mathematicians but to encourage citizens who will contribute meaningfully to the growth and development of the country and excel in various disciplines of knowledge.

It gives me immense pleasure to thank and acknowledge with gratitude the efforts put by the students and faculty members who are associated with the bringing out the e-magzine in the present commendable form. I am sure the Department Society ASYMPTOTE will continue to bring out future editions periodically of the e-magzine for the latest development in the Mathematics field.

MS. GUPREET KAUR
TEACHER In-charge

## OUR FACULTY

- Ms. Gurinderjit Kaur (M.Sc.)
- Ms. Mandeep Walia (M.Sc., M.Phil.)
- Dr. Rama Verma (M.Sc., Ph.D.)
- Dr. Rashmi Verma (M.Sc., Ph.D.)
- Ms. Gurpreet Kaur (M.Sc., M.Phil.)
- Ms. Sonia Aneja (M.A., M.Phil.)
- Ms. Meena Baweja (M.A., M.Phil.)
- Ms. Pooja Louhan (M.Sc.)
- Ms. Pooja Sharma (M.A.)
- Ms. Preeti (M.Sc., M.Phil.)
- Ms. Karuna Mamtani (M.Sc.)


## Mathematics Society

## ASYMPTOTE

- Mahima Khanna (President)
- Kamna Mamgain (Vice-President)
- Priyanka Panwar (Secretary)
- Priyanka Sharma (Joint Secretary)

# MATHEMATICS TODAY

## 1. Largest known prime number discovered in Missouri

The largest known prime number has been founded by a computer programme at a US university. Prime numbers can only be divided by themselves and one, and are vital for computer encryption. The new number - written as 2^74,207,281-1 - is more than 22 million digits long and was published by Dr Curtis Cooper at the University of Central Missouri. He discovery was part of the Great Internet Mersenne Prime Search (Gimps) programme to find new prime numbers. The number is five million longer than the previous largest prime found in 2013 which was also discovered by Dr Cooper using the computer software. Prime numbers are used by online banking, shopping private message services as encryption keys to protect data.

## 2. Math experts stunned as they crack a pattern for prime numbers :

Two academics have shocked themselves and the world of mathematics by discovering a pattern in prime numbers. Primes - numbers greater than 1 that are divisible only by themselves and 1 – are considered the 'building blocks' of mathematics, because every number is either a prime or can be built by multiplying primes together - (84, for example, is 2x2x3x7). Their properties have baffled number theorists for centuries, but mathematicians have usually felt safe working on the assumption they could treat primes as if they occur randomly. Now, however, Kannan Soundararajan and Robert Lemke Oliver of Stanford University in the US have discovered that when it comes to the last digit of prime numbers, there is a kind of pattern. Apart from 2 and 5, all prime numbers have to end in 1, 3, 7 or 9 so that they can't be divided by 2 or 5. So if the numbers occurred randomly as expected, it wouldn't matter what the last digit of the previous prime was. Each of the four possibilities – 1, 3, 7, or 9 – should have an equal 25 per cent (one in four) chance of appearing at the end of the next prime number.

## 3. Crunching the number :

Researchers use math in search for diabetes cure : Researchers at Florida State University's biomathematics program are using a mix of math and technology in an ambitious search for a cure to Type 2 diabetes. New research by mathematics Professor Richard Bertram has successfully reactivated oscillations in insulin-producing pancreatic beta cells -- one of the first necessary steps to resurrecting the dormant cells and restoring the production of insulin.

4. **Mathematical analysis reveals architecture of the human genome :**

Mathematical analysis has led researchers in Japan to a formula that can describe the movement of DNA inside living human cells. Using these calculations, researchers may be able to reveal the 3D architecture of the human genome. In the future, these results may allow scientists to understand in detail how DNA is organized and accessed by essential cellular machinery.

5. **Pi might look random but it's full of hidden patterns :**

After thousands of years of trying, mathematicians are still working out the number known as pi or "π". We typically think of pi as approximately 3.14 but the most successful attempt to calculate it more precisely worked out its value to over 13 trillion digits after the decimal point. We have known since the 18th century that we will never be able to calculate all the digits of pi because it is an irrational number, one that continues forever without any repeating pattern.

6. **Researchers use mathematical modeling to explain evolutionary phenomenon that leads to treatment resistance :**

Modern medicine and treatments for bacterial infections and cancer have significantly increased life spans and improved quality-of-life. However, many drugs eventually fail because of the outgrowth and survival of treatment-resistant populations. A collaborative team of researchers from Moffitt Cancer Center's Integrated Mathematical Oncology (IMO) Program, led by Alexander Anderson, Ph.D., and Oxford University's Department of Computer Science are using mathematical models to explain how bacteria and cancer cells exploit an evolutionary process known as bet-hedging to resist medical intervention.

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**SOURCE** : www.sciencedaily.com/news/computers_math/mathematics

# MATHEMATICS AND LIFE

**-Ms. Pooja Sharma & Simran Minocha**

Math, as known to most of us, is a subject which has many complex formulae, problems, and theorems. We all know that probability, statistics, mathematical modeling, calculus, etc have their applications in various fields. Mathematics is present everywhere; may it be, banking, insurance, astronomy, biology, physics, psychology. Mathematics is the cradle of all creations.

Mathematics makes lives orderly and prevents chaos. Certain qualities that are nurtured by mathematics are power of reasoning, creativity, abstract and critical thinking, problem-solving ability and even effective communication skills.

Mathematics is not what we invented, it is what we discovered. 1, 1, 2, 3, 5, 8, 13... This is the *Fibonacci Sequence*, where each number is derived from adding the previous two numbers. This sequence of numbers can be found in many natural patterns like in pineapples, sunflowers and pine cones. Even the logos of cars, companies are all *symmetrical*.

We find *mathematics in music, beats, rhythms , dances*. Sounds produced by musical instruments can be expressed in certain functions! It is widely believed that students who do well in music also excel in math. In music, the Fibonacci sequence can be seen in piano scales. For example, the C scale on the piano consists of 13 keys from C to C; eight white keys and five black keys, with black keys arranged in groups of three and two. The closest tie between music and math is patterns. Musical pieces often have repeating choruses or bars, similar to patterns. In mathematics, we look for patterns to explain and predict the unknown. Music uses similar strategies. When looking at a musical piece, musicians look for notes they recognize to find notes that are rare (high or low) and less familiar. In this way, notes relate to each other. Relationships are fundamental to mathematics and create an interesting link between music and math.

*Dyscalculia* is difficulty in learning or comprehending arithmetic, such as difficulty in understanding numbers, learning how to manipulate numbers, and learning math facts. It is generally seen as a specific developmental disorder like dyslexia. People suffering from this condition have problem in counting and measuring things due to which they are not able to perform daily life activities as smoothly as normal people do.

Math is one of the building blocks of human knowledge and social progress - without proper calculations and math conclusions; it is not possible to estimate or to budget properly. Living a life without knowing 'Math' would be like living in null and void. Modern life style is completely handicapped and highly improbable, in the absence of mathematics. Unless we are well versed with numbers, it will be difficult to deal with day to day life. Be it to shop wisely, or refashion a home within a budget, knowledge of mathematics holds the key, and is hence, inevitable.

## CAREER PROSPECTS IN MATHEMATICS

**- Ms. Pooja Louhan & Ms. Karuna Mamtani**

Mathematics encompasses many topics of study and it comes from a Greek word meaning "*inclined to learn*". It may, however, be broadly defined as the scientific study of quantities, including their relationships, operations and measurements expressed by numbers and symbols.

Learning mathematics teaches one to think logically and analytically. Because of this, there is a lot of demand for qualified mathematicians (with a B.Sc or higher degree) from various scientific institutions, industries, and business and commercial oragnisations. There are various institutes offering math education and research of world repute in India, few of which are listed below. The information about these institutions has been gathered from their web-pages and other publicly available sources.

The regular route for a student is a three-year B.Sc. course followed by a two-year M.Sc. programme in mathematics, after which she or he could join a doctoral programme in a recognized university or research institution.

**Master's Degree and Integrated MSc-PhD courses**

At the Master's degree level, Mathematics is offered by more than 135 universities in India. Student can also apply for an Integrated MSc-PhD degree offered at some places in India. Several institutions are providing higher mathematics education in India, to name a few :

- **Indian Statistical Institute (ISI)** offers Masters degree in Mathematics, Statistics and many other fields. Selection for admission is based on merit, written test and interview. Students admitted to this course are also provided initial stipend.
  Link: http://www.isibang.ac.in/~statmath/courses/mmath.html

- **Indian Institute of Science (IISc)** The short-listing of candidates for interview is done based on the performance in JAM (Mathematics (MA) , Mathematical Statistics (MS)).
  Link: http://www.iisc.ac.in/admissions/ph-d-integratedprogrammes/

- **Tata Institute for Fundamental Research (TIFR)** offers an integrated MSC-PhD programme and a separate PhD programme. Selection to these courses is through a written test which is followed by an interview.
  Link: http://www.math.tifr.res.in/graduate/overview.php

- **The Institute of Mathematical Sciences(IMSc)**, Chennai offers an integrated MSc-PhD program and admits through National Board for Higher Mathematics (NBHM) Ph.D scholarship Screening Test followed by an interview.
  Link: https://www.imsc.res.in/phd_programme_mathematics

- **Harish Chandra Research Institute (HRI),** Allahabad conducts a regular Ph.D. as well an integrated M.Sc.-Ph.D. program in mathematics, in

collaboration with the Homi Bhaba National Institute (HBNI) and the University of Allahabad. Students are selected through NBHM research fellowship together with an interview. However, successful Council for Science and Industrial Research (CSIR) Research Fellowship holders are also eligible for appearing in the interview.
Link: http://www.hri.res.in/academics/mathematics/grad-studies/

- An Integrated MSc degree (BS-MS Dual Degree Program) is offered by the **Indian Institutes of Science Education and Research** (IISER) at Pune, Mohali, Kolkata, Trivandrum and Bhopal, and also at the **National Institute of Science Education and Research** (NISER) at Bhubaneswar. The IISER admits students via IIT JEE, Kishore Vaigyanik Protsahan Yojana (KVPY) and through board exam performances, while the NISER admits students through the National Entrance Screening Test (NEST).
Links: https://www.iiseradmission.in/ ; http://www.niser.ac.in/

**Fellowships and Training Programs**

- **NBHM, CSIR & DST:** At research levels, funding can be obtained from the Institutes listed above and also from National Board for Higher Mathematics (NBHM), Council for Science and Industrial Research (CSIR), and the Department of Science and Technology (DST).
Links: http://www.nbhm.dae.gov.in/ ; http://csirhrdg.res.in/ ; http://www.dst.gov.in/fellowship-opportunities-researchers .

- **Mathematics Training and Talent Search Program (MTTS)**: These training programs are meant for students who are already learning mathematics, atleast second year undergraduate level. The selection is purely on merit, based on consistently good academic record and the recommendation letter from a mathematics professor.
Link: http://www.mtts.org.in/

- **Advanced Training in Mathematics (ATM) schools**: under this scheme, various workshops and training programs are conducted for providing training in core subjects in Mathematics to Ph.D. students and young researchers.
Link: http://www.atmschools.org/

- **Summer Research Fellowships**: Some institutes mentioned above provide funding for short term academic visits. Summer Fellowships are also awarded to bright students and motivated teachers to work with Fellows of the **Indian Academy of Sciences** on research-oriented projects.
Link: http://web-japps.ias.ac.in:8080/SEP/SummerFellowships.jsp

**RESEARCH**

There are three kinds of institutions of higher learning:

1. **Purely research-oriented institutions** like the Tata Institute of Fundamental Research (TIFR) in Mumbai, the Institute of Mathematical Sciences (IMSc) in Chennai, and the Harish Chandra Research Institute (HRI) in Allahabad. All

these are autonomous aided institutions that are fully supported by the Department of Atomic Energy (DAE) of the Government of India.

2. **Institutions of teaching and research** that offer degrees and have been set up by Acts of Parliament, and some come under the Ministry of Human Resource Development (MHRD). These are the Indian Statistical Institute (ISI), the IITs, the IISc, and the newly set up Indian Institutes of Science Education and Research (IISERs) in Bhopal, Kolkata, Mohali, Pune and Thiruvananthapuram, and the National Institute of Science Education and Research (NISER) in Bhubaneswar (set up by the DAE). Chennai Mathematical Institute (CMI), is an example of public-private partnership. ISRO has also established its own such institution in Thiruvananthapuram.

3. **The State and Central universities**.

However, there are the following variants to this theme:

1. The Indian Institute of Science (IISc) Bangalore offers a unique 4-year Bachelor of Science (Research) programme, which can also be extended to the fifth year to obtain a Master of Science (M.S.) degree.

2. The 3-year B.Sc. (Hons.) in Mathematics and Computer Science of the CMI, Chennai and Bachelor of Mathematics (B.Math.) of the ISI Bangalore campus.

3. The IIT-Kanpur pioneered the five-year M.Sc. programme which combined the B.Sc. and M.Sc. programmes. IIT-Bombay followed suit. Now, this pattern is followed by all the IISERs and NISER. The Central University of Hyderabad and that of Pondicherry have also started such programmes.

4. All the IITs and universities also have independent M.Sc. and Ph.D. programmes. Admission is based on entrance tests and/or interview. The CMI has an M.Sc. programme in applications of mathematics with specialization in financial mathematics and computational applications of mathematics. The ISI has an M. Math. Programme, held alternatively at its Kolkata and Bangalore campuses.

5. Institutions of pure research (the TIFR, the IMSc and the HRI), the IISc and the CMI also have integrated Ph.D. programmes. Promising students are selected after a bachelor's degree in any science discipline or engineering directly for their Ph.D. programmes, provided they clear the entrance tests and interviews on a par with M.Sc. candidates. They pick up an M.Sc. degree after two initial years of course work and research.

It is indeed possible to build a perfectly satisfying career in mathematics if one is deeply interested in the subject. A trained mathematician can be very well employed in academia, space research (**Indian Space Research Organisation, or ISRO**), defence research (**Defence Research and Development Organisation, or DRDO**), aeronautical research (**National Aeronautics Limited, or NAL**), **Society for Electronic Transactions and Security (SETS) ,** computer giants such as **IBM** and **Microsoft**, etc.

## ACHIEVEMENTS IN THE FIELD OF MATHEMATICS

**-Priyanka Panwar**

*"The laws of mathematics, having relation to real world, are unreliable and robust mathematical laws are not relevant to the real world."*

*-Albert Einstein.*

The development of mathematics is intimately interwoven with the progress of civilization, influencing the course of history through its application to science and technology. The earliest records of mathematics show it arising in response to practical needs in agriculture, business, and industry. There have been some amazing discoveries made recently on the many subjects of mathematics field.

**Manjul Bhargava the first person of Indian origin to win the Fields Medal, popularly known as the Noble of Mathematics.**

Manjul Bhargava, a Canadian mathematician of Indian origin, has been awarded the prestigious 2014 Fields Medal at the International Mathematical Union's (IMU) International Congress held in Seoul. Bhargava was awarded the medal "for developing powerful new methods in geometry of numbers, which he applied to count rings of small rank and to bound the average rank of elliptic curves", IMU said. One of the Bhargava

's most prominent discoveries was a thesis that threw a new light on the Gauss's Law for the composition of two binary quadratic forms.

## RAMANUJAN SURPRISES AGAIN

Two mathematicians of Emory University, Ken Ono and Sarah Trebat-Leder, have recently made a fascinating discovery within its yellowed pages. The romanticism rubbed off on the number 1729, which plays a central role in the Hardy-Ramanujan story. Ono and Granville spotted the famous number even though it didn't itself appear on the page. Ramanujan had only written down the equation $1^3 + 12^3 = 9^3 + 10^3$. Pythagoras' theorem tells us that if a right-angled triangle has sides of lengths x, y, and z being the longest side, then the three lengths satisfy the equation

$$x^2 + y^2 = z^2.$$

There are infinitely triples of positive whole numbers $x$, $y$ and $z$, which satisfy this relationship. A natural question is whether you can also find three positive whole numbers (excluding 0s) satisfying the equation:

$$x^3 + y^3 = z^3,$$

Or

$$x^4 + y^4 = z^4,$$

Or

$$x^5 + y^5 = z^5,$$

And so on. In 1637 the French mathematician Pierre de Fermat confidently asserted that the answer is no. What the equation in Ramanujan's manuscript illustrates is that Ramanujan had found a whole family (in fact an infinite family) of positive whole number triples $x$, $y$ and $z$ that very nearly, but not quite, satisfy Fermat's famous equation for $n = 3$. They are off only by plus or minus one, that is, either

$$x^3 + y^3 = z^3 + 1$$

Or

$$x^3 + y^3 = z^3 - 1.$$

*Elliptic curves and climbing K3*

But this isn't all. When Ono and his graduate student Sarah Trebat-Leder decided to investigate further, looking at other pages in Ramanujan's work, they found he had developed a sophisticated mathematical theory that went beyond anything people had suspected**.** It turns out that from looking at equations of the form:

$$x^3 + y^3 = z^3$$

It's not too large a mathematical step to considering equations of the form

$$y^2 = x^3 + ax + b,$$

Where $a$, $b$ and $c$ are constants. If you plot the points $(x, y)$ that satisfy such an equation (for given values of $a$ and $b$) in a coordinate system, you get a shape called an *elliptic curve.* Ono and Trebat-Leder found that Ramanujan had also delved into the theory of elliptic curves. When objects of this kind were rediscovered around forty years later they were adorned with the name of *K3 surfaces*. But his work on the surface also provided an unexpected gift to Ono and Trebat-Leder, which links back to elliptic curves. Like all equations, any elliptic curve equation

$$y^2 = x^3 + ax + b,$$

cries out for solutions: naturally pairs of numbers $(x, y)$ that satisfy the equation.

And this is exactly what Ramanujan came up with. His work on the K3 surface he discovered provided Ono and Trebat-Leder with a method to produce, not just one, but infinitely many elliptic curves requiring two or three solutions to generate all other solutions. It's not the first method that has been found, but it required no effort. "We tied the world record on the problem [of finding such elliptic curves], but we didn't have to do any heavy lifting," says Ono. "We did next to nothing, expect recognise what Ramanujan did."

# PARADOX AND MATHEMATICAL FALLACIES

- **Compiled By: Ms. Preeti**

## Liar Paradox

The first sentence in this essay is a lie. There is something odd about saying so, as has been known since ancient times. To see why, remember that all lies are untrue. Is the first sentence true? If it is, then it is a lie, and so it is not true. Conversely, suppose that it is not true. We (viz., the authors) have said it, and normally things are said with the intention of being believed. Saying something that way when it is untrue is a lie. But then, given what the sentence says, it is true after all!

That there is some sort of puzzle to be found with sentences like the first one of this essay has been noted frequently throughout the history of philosophy. It was discussed in classical times, notably by the Megarians, but it was also mentioned by Aristotle and by Cicero. As one of the insolubilia, it was the subject of extensive investigation by medieval logicians such as Buridan. More recently, work on this problem has been an integral part of the development of modern mathematical logic, and it has become a subject of extensive research in its own right. The paradox is sometimes called the 'Epimenides paradox' as the tradition attributes a sentence like the first one in this essay to Epimenides of Crete, who is reputed to have said that all Cretans are always liars. That some Cretan has said so winds up in no less a source than New Testament.

Lying is a complicated matter, but what's puzzling about sentences like the first one of this essay isn't essentially tied to intentions, social norms, or anything like that. Rather, it seems to have something to do with truth, or at least, some semantic notion related to truth. The puzzle is usually named 'the Liar paradox', though this really names a family of paradoxes that are associated with our type of puzzling sentence. The family is aptly named one of paradoxes, as they seem to lead to incoherent conclusions, such as: "everything is true". Indeed, the Liar seems to allow us to reach such conclusions on the basis of logic, plus some very obvious principles that have sometimes been counted as principles of logic. Thus, we have the rather surprising situation of something near or like logic alone leading us to incoherence. This is perhaps the most virulent strain of paradox, and dealing with it has been an important task in logic for about as long as there has been logic.

### 1. SIMPLE-FALSITY LIAR

Consider a sentence named 'FLiar', which says of itself (i.e., says of FLiar) that it is false.

**FLiar**: FLiar is false.

This seems to lead to contradiction as follows. If the sentence 'FLiar is false' is true, then given what it says, FLiar is false. But FLiar just is the sentence 'FLiar is false', so we can conclude that if FLiar is true, then FLiar is false. Conversely, if FLiar is false, then the sentence 'FLiar is false' is true. Again, FLiar just is the sentence

'FLiar is false', so we can conclude that if FLiar is false, then FLiar is true. We have thus shown that FLiar is false if and only if FLiar is true. But, now, if every sentence is true or false, FLiar itself is either true or false, in which case—given our reasoning above—it is both true and false. This is a contradiction. Contradictions, according to many logical theories (e.g., classical logic, intuitionistic logic, and much more) imply absurdity—triviality, that is, that every sentence is true.

An obvious response is to deny that every sentence is true or false, i.e., to deny the principle of bivalence. Even so, a simple variant Liar sentence shows that this immediate answer is not all there is to the story.

## 2. SIMPLE-UNTRUTH LIAR

Rather than work with falsehood, we can construct a Liar sentence with the complex predicate 'not true'. Consider a sentence named 'ULiar' (for 'un-true'), which says of itself that it is not true.

**ULiar**: ULiar is not true.

The argument towards contradiction is similar to the FLiar case. In short: if ULiar is true, then it is not true; and if it is not true, then it is true. But, now, if every sentence is true or not true, ULiar itself is true or not true, in which case it is both true and not true. This is a contradiction. According to many logical theories, a contradiction implies absurdity—triviality.

The two forms of the Liar paradox we have so far reviewed rely on some explicit self-reference—sentences talking directly about themselves. Such explicit self-reference can be avoided, as is shown by our next family of Liar paradoxes.

## 3. LIAR CYCLES

Consider a very concise (viz., one-sentence-each) dialog between siblings Max and Agnes.

- **MAX**: Agnes' claim is true.
- **AGNES**: Max's claim is not true.

What Max said is true if and only if what Agnes said is true. But what Agnes said (viz., 'Max's claim is not true') is true if and only if what Max said is not true. Hence, what Max said is true if and only if what Max said is not true. But, now, if what Max said is true or not true, then it is both true and not true. And this, as in the FLiar and ULiar cases, is a contradiction, implying, according to many logical theories, absurdity.

Liar paradoxes can also be formed using more complex sentence structure, rather than complex modes of reference. One that has been important involves Boolean compounds.

## 4. BOOLEAN COMPOUNDS

Boolean compounds can enter into Liar sentences in many ways. One relatively simple one is as follows. Consider the following sentence named 'DLiar' (for 'Disjunctive').

**DLiar**: Either DLiar is not true or 1=0.
First, observe that if DLiar is not true, then it must be true. If DLiar is not true, then by similar reasoning to what we saw above, we have that the left disjunct of DLiar is true. But a disjunction is true if one of its disjuncts is, so DLiar is true. Thus, if DLiar is not true, it is true and not true, and we have a contradiction. By reductio, then, it must be true; so one of its disjuncts must be true. If it's the first one, we have a contradiction, so it must be the second one; we can conclude that 1=0. We have thus proved that 1=0. Moreover, the sentence '1=0'played no real role in the above reasoning. We could replace it with any other sentence to get a proof of that sentence.

## 5. INFINITE SEQUENCES

The question of whether the Liar paradox really requires some sort of circularity has been the subject of extensive debate. Liar cycles (e.g., the Max–Agnes dialog) show that explicit self-reference is not necessary, but it is clear that such cycles themselves involve circular reference. Yablo (1993b) has argued that a more complicated kind of multi-sentence paradox produces a Liar without circularity.

Yablo's paradox relies on an infinite sequence of claims A_0, A_1, A_2, ..., where each Ai says that all of the 'greater' Ak (i.e., the Ak such that k>i) are untrue. (In other words, each claim says of the rest that they're all untrue.) Since we have an infinite sequence, this version of the Liar paradox appears to avoid the sort of circularity apparent in the previous examples; however, contradiction still seems to emerge. If A0 is true, then all of the 'greater' Ak are untrue, and *a fortiori* A1 is untrue. But, then, there is at least one true Ak greater than A1 (i.e., some Ak such that k>1), which contradicts A0. Conversely, if A0 is untrue, then there's at least one true Ak greater than A0. Letting Am be such a one (i.e., a truth greater than A0), we have it that Am+1 is untrue, in which case there's some truth greater than Am+1. But this contradicts Am. What we have, then, is that if A0 (the first claim in the infinite sequence) is true or untrue, then it is both. And this, as in the other cases, is a contradiction.

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**SOURCE :** https://plato.stanford.edu/entries/liar-paradox/

# MATHEMATICAL FALLACIES

*Mathematical fallacies* are errors, typically committed with an intent to deceive, that occur in a mathematical proof or argument. A fallacy in an argument doesn't necessarily mean that the conclusion is necessarily incorrect, only that the argument itself is wrong. However, fallacious arguments can have surprising conclusions, as shown below:

## 1. DIVISION BY ZERO

1. Let $x = 1$

2. Multiply both side by $x$ $x^2 = x$

3. Subtract 1 from both sides $x^2 - 1 = x - 1$

4. Divide both sides by $x - 1$ $x^2 - 1 / \boxed{x - 1} = 1$

5. Simplify $(x - 1)(x + 1) / \boxed{x - 1} = 1$

$x + 1 = 1$

6. Subtract 1 from both sides $x = 0$

7. Substitute the value of $x$ from step 1: $1 = 0$

The fallacy here is subtle. In step 2, multiplying both sides by $x$ introduces an extraneous solution to the equation of $x = 0$. Then, in step 4, there is a division by $x - 1$, which is an illegal operation because $x - 1 = 0$ and you can't divide by zero. This illegal operation has the effect of leaving the extraneous solution $x = 0$ as the only solution to the equation.

You can use a similar method to "show" that any number is equal to any other number. For example, to show that $7 = -4$:

$x = 7$

$x - 7 = 0$

$(x - 7)(x + 4) = 0$ [multiply both sides by $x + 4$]

$x + 4 = 0$ [divide both sides by $x - 7$]

$x = -4$

## 2. INFINITE SERIES FALLACIES

If you've taken mathematics in high school or first-year university or college, you may have learned that an infinite geometric series has a sum if it is convergent; that is, if the ratio between any term and the previous term is less than 1 and greater than −1. Geometric series that are not convergent cannot be summed. If you ignore this, then you can come up with all kinds of strange results. For example:

$S = 1 - 1 + 1 - 1 + 1 - 1 + 1 - \ldots$

Grouping the terms, we get:

$S = (1 - 1) + (1 - 1) + (1 - 1) + \ldots$

$S = 0 + 0 + 0 + 0 + \ldots$

$S = 0$

However, we could also group the series differently:

$S = 1 - 1 + 1 - 1 + 1 - 1 + 1 - \ldots$

$S = 1 + (1 - 1) + (1 - 1) + (1 - 1) + \ldots$

$S = 1 + 0 + 0 + 0 + 0 + \ldots$

$S = 1$

Since $S$ is equal to both 1 and 0, then $1 = 0$.

Here's another example:

$S = 1 + 2 + 4 + 8 + 16 + 32 + \ldots$

$S - 1 = 2 + 4 + 8 + 16 + 32 + \ldots$

Now, we can multiply the original equation by 2, getting:

$2S = 2 + 4 + 8 + 16 + 32 + \ldots$

Both the second and third equation have the same sum, so:

$2S = S - 1$

$S = -1$

But it is absurd that the sum of this series could be negative, since all of the terms are positive. The fallacy lies in assuming that a divergent series has a sum.

# "PROOF" THAT YOU NEVER GO TO SCHOOL

You may have once seen a "proof" that you never go to school (or work), all appearances to the contrary notwithstanding. It might have gone something like this:

- There are 365 days in a year.
- But you don't go to school on Saturdays or Sundays; there are 104 of these, so 365−104 = 261.
- You don't go to school on summer vacation either; the length of summer vacation varies, but say that it's 68 days long, so 261−68 = 193.
- You also get Christmas vacation off, which is 16 days long; 193−16 = 177.
- You also get March break or spring break off, which is 9 days long; 177−9 = 168.
- School doesn't last all day though; maybe you have 8 40-minute classes each day, so 168 × 8 × 40/60 = 896 hours.
- However, most jurisdictions have about 12 statutory holidays each year, and you don't go to school at all on those days; 896−12×24 = 608.
- There are also a few (say, five) professional development days in the school calendar, so 608−5×24 = 488.
- Of course, there are some days you don't go to school at all, either because you're sick or you have an appointment or your parents took you somewhere or you didn't want to go. Say there are five such days each year. 488−5×24 = 368.
- While you're at school, you probably get about an hour every day for lunch and/or recess; 368−365 = 3.
- The first day of school is usually a half day, so subtract 3 hours: 3−3 = 0.
- Therefore, you don't go to school at all.

But (assuming you're a student) you do go to school, so what's gone wrong? The problem is that a lot of times when you don't go to school are counted multiple times. For example, a summer Sunday is subtracted when accounting for Sundays and again when accounting for summer vacation.

The above was just for fun, but there is a real world lesson to be learned here. Sometimes you'll see in the news some claim that shoplifting, or mental illness, or goofing off on the Internet at work, or something else costs some enormous sum of money, or that some new government spending programme will create some enormous number of jobs. You can probably bet that, just like the example above, there was a lot of counting things twice, three times, or even more.

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**SOURCE:** http://mathlair.allfunandgames.ca/

## Mathematics is FUN

- **SUDOKU**

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

**OH ! CALCULUS**

*Oh Calculus , Oh Calculus!*
*Oh Calculus , Oh Calculus,*
*How tough are both your branches,*
*Oh Calculus , Oh Calculus,*
*To pass , what are my chances?*
*Derivatives I cannot take,*
*At Integrals , my fingers shake,*
*Oh Calculus , Oh Calculus,*
*How tough are both your branches.*

*Oh Calculus , Oh Calculus,*
*Your theorems I cannot master,*
*Oh Calculus , Oh Calculus,*
*My proofs are a disaster*
*You pull a trick out of the air*
*Or find a reason , who knows where*
*Oh Calculus , Oh Calculus,*
*Your theorems I cannot master.*

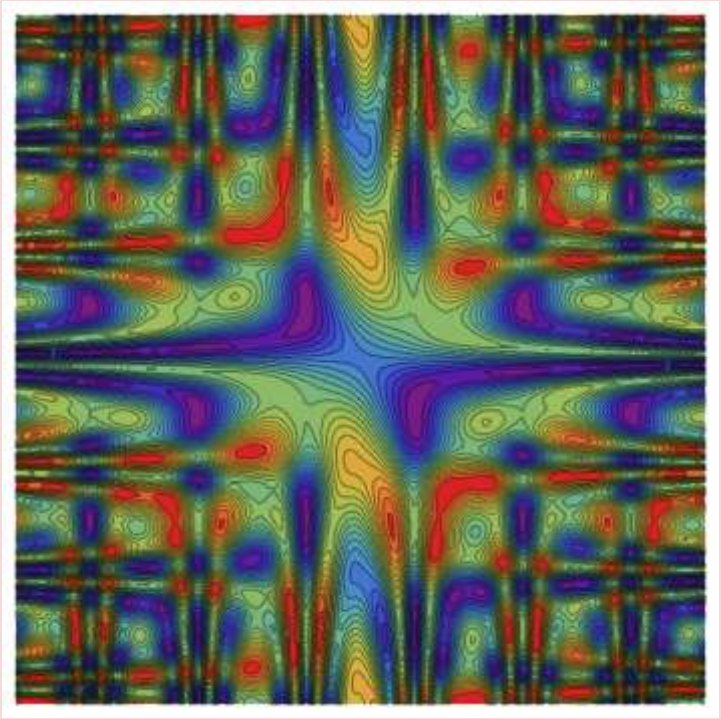
*Oh Calculus , Oh Calculus,*
*Your problems do distress me,*
*Oh Calculus , Oh Calculus,*
*Related rates depress me*
*I walk toward lamppost in my sleep*
*And running water makes me weep*
*Oh Calculus , Oh Calculus,*
*Your problems do distress me.*

*Oh Calculus , Oh Calculus,*
*My limit I am reaching,*
*Oh Calculus , Oh Calculus,*
*For mercy I am beseeching*
*My grades to not approach a B,*
*They're just an epsilon from D,*
*Oh Calculus , Oh Calculus,*
*My limit I am reaching.*

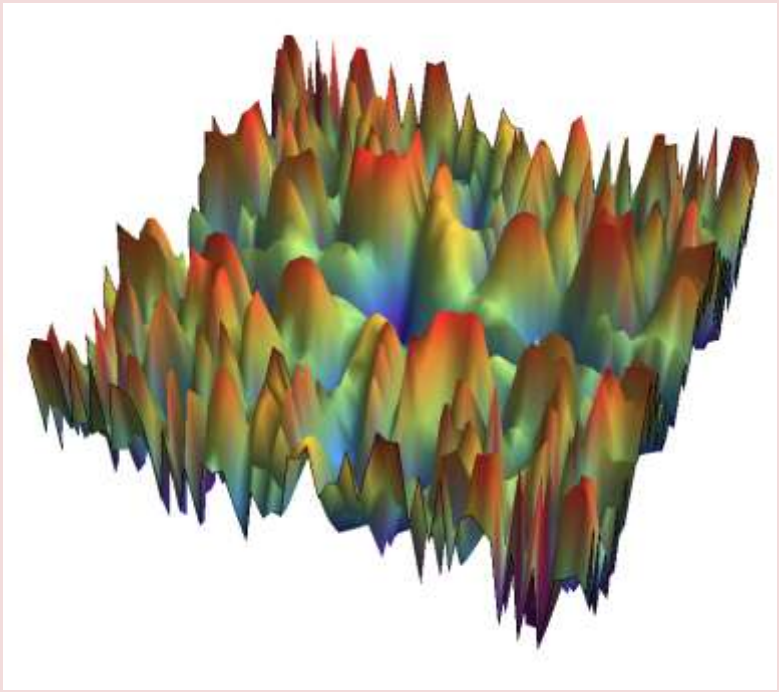
**- PRIYANSHI**

Sometimes the plot of a simple function can be amazingly intricate...
For example, **sin (x sin y) - cos(y cos x)**

```
ContourPlot[Sin[x*Sin[y]]-Cos[y*Cos[x]],{x,-10,10},{y,-
10,10},ContourShading → Automatic,ColorFunction →
"Rainbow",Contours → 20,Axes→False,Frame→False]
```



```
Plot3D[Sin[x*Sin[y]]-Cos[y*Cos[x]],{x,-10,10},{y,-
10,10},Mesh→None,ColorFunction →
"Rainbow",Boxed→False,Axes→False]
```



# MATHEMATICS SOCIETY :
# ASYMPTOTE

## REPORT

The Department of Mathematics, Mata Sundri College for Women is having a very dynamic Mathematical Society named “Asymptote”, which is very enthusiastically handled by the students and teachers. The President of Asymptote for the year 2016-2017 is Mahima Khanna (III$^{rd}$ Year) and the Vice President is Kamna Mamgain (II$^{nd}$ Year). There are two secretaries of Asymptote this year, Priyanka Sharma and Priyanka Panwar, both from I$^{st}$ Year. Asymptote has been actively organizing events all round the year.

Two events, namely “Paper presentation” and “Poster making and Sudoku” were organized under the Annual mathematical event Mathemania 2016. The society also organised the screening of movie “The man who knew infinity”, which is based on the life of the great Indian mathematician Srinivasa Ramanujan. The last event of the department was an inter-college workshop and rangoli competition held in February 2017. The detailed description of all the events is as follows:

## INTER COLLEGE WORKSHOP: THE WORLD WITHIN YOUR REACH AND INTER-COLLEGE RANGOLI MAKING COMPETITION

Department of Mathematics organised an inter-college workshop, "The World Within Your Reach" on 3$^{rd}$ February 2017 at Mata Gujri Hall of the college. The workshop had been planned incorporating two interactive sessions –"Spreading Your Wings" and "Success @Interviews" that aimed to guide students through the various career options. The workshop was then followed by an inter-college Mathematical Rangoli Competition.

The programme started with the first interactive session- "Spreading Your Wings" with Dr. Asha Gauri Shankar, Associate Professor (Retd.), Lakshmibai College, Delhi University. This session dealt with the diverse nature of Mathematics and the various opportunities this field has to offer to them. The students were enlightened about the speciality of this subject and how it makes one an all-rounder in all fields. The students were encouraged to pursue higher studies and continue aiming high, at the same time keeping in mind their well being in all respects. Following this session, the programme was followed by another interactive session- "Success @Interviews" with Dr. Gauri Shankar, Professor, International Management Institute, Delhi. This session intended to develop certain skills in students that would help them face interviews with confidence. In the later session, a few case studies with regard to interview sessions were taken up which was followed by questions.

The Inter College Mathematical Rangoli Competition commenced at 2:00 PM outside Mata Gujri Hall. Total 6 six teams of 2 participants each participated in the competition. The result declaration and prize distribution ceremony took place at 3:30 PM. The winning teams were awarded with cash prizes worth Rs.1000 and Rs.700.


## ALUMNI MEET

The Department of Mathematics organized the departmental alumni meet on January 14, 2017. The special guests of the event were Dr. Kanwarjit Kaur (Principal, Mata Sundri College for Women), Dr. Manmohan Kaur (Principal, SGND Khalsa, Dev Nagar, Former Associate Professor. at Departement of Mathematics, Mata Sundri College for Women), Dr. Shashi Kiran (Associate Professor (Retd.) Departement of Mathematics, Mata Sundri College for Women and 30 alumnae.

The meeting came to order at 16:00. The event was given an auspicious start by reciting college's prayer by students from second year. After the prayer, principal ma'am addressed the gathering. She first welcomed the Alumni along with the guests. She stressed over the fact that the alumni truly represent the college in the outside world and college's pride depends upon their growth. She appealed the alumni to volunteer for the two positions in alumni association, fill honestly the feedback form and keep college updated. Following which, our special guest of the day, Dr. Manmohan Kaur enlightened each one among the audience with her inspiring words. She urged alumni to spread the greatness of the college, to make a unique identity for themselves and quoted the shabad : *''Jaisa sevai, taisa hoye..*" She also emphasized on the importance of Mathematics by calling the subject as

the backbone of all science and as the universal language. She urged the alumni to stay connected and ended her address by the quote: "*Mathematics is the King of all the subjects…so become the Queen of the world*"

After the words of wisdom by our special guests, the event took an entertaining turn with a series of cultural events. There were a variety of events including various song and dance performances. This was followed by a video that refreshed the beautiful memories of the past for the alumnae as well as for the teachers. There was also a presentation of instrumental piece on xylophone and a skit that was scripted by directed by the students themselves. After the cultural event, all the alumnae were invited to share their experience during and after the graduation . Ms. Gurpreet Kaur, (Teacher Incharge, Dept. of Mathematics) then concluded the programme by presenting the vote of thanks and inviting everyone for light refreshments. We look forward towards more of such reunions, that will not only keep us connected but will also bring us closer, ..*stronger*.


## MOVIE SCREENING

The Department of Mathematics of Mata Sundri College for Women organized the screening of the movie "The Man Who Knew Infinity" on 3rd November 2016 in Mata Sahib Kaur Auditorium of the college.

As goes the title of the movie, "The Man Who Knew Infinity" is the true story of friendship of Srinivasa Ramanujan (Dev Patel) and Professor G. H. Hardy (Jeremy Irons) that forever changed the world of Mathematics. Hardy was the man instrumental in getting Ramanujan's work out in the world. The film also stars Devika Bhise, Stephen Fry and Toby Jones. This is Ramanujan's story as seen through Hardy's eyes.

The numbers that turned up was quite impressive. There was no commotion during the screening, which was a clear proof of a gripping story. The students from all the departments were cordially invited,

yet the discipline was maintained, making the event a grand success.

The motive of the screening was to tell an important story and it does make a meal out of the subject. Ramanujan's tale needed an audience because in terms of achievement his contribution to the world of mathematics was truly astonishing. Ramanujan is a part of history and his legacy is on par with the likes of C. V. Raman and Homi Bhabha. "The Man who knew Infinity" is indeed an inspiring tale. We look forward to more of such movie screenings which provide the stories of courage, hard work and motivation for the young minds.

## PAPER PRESENTATION

In today's competitive world it is very necessary for a student to have good communication and presentation skills. These days whatever role you have in business or the corporate world or teaching profession, your success will be directly related to your ability to influence others. Therefore, one of the important attributes for successful people today is the ability to present well. It's not just what you know that counts but what also matters is how you present your knowledge to the world. Delivering accomplished presentations is a vital skill in anyone's armory whether you are a student just starting out or the head of a large organization.


That is why our department organized a paper presentation competition for our students. The main goals of paper presentation for the students is to enhance their critical thinking skills and to make them use various resources to locate and extract information using offline & online tools and journals. By participating in such competitions the student practices the preparation and presentation of scientific papers and seminars in an exhaustive manner. Through in-depth research of a specific chosen topic students will be exposed to all kind of literature available on internet as well as in the college libraries.

The paper presentation competition was conducted on 19th September, 2016 in Mata Gujri hall of the college. The programme commenced at 11:00 AM. Seven teams of two students and three students individually participated in paper presentation and presented various topics of Mathematics. Each presentation was critically analyzed by the judges, Mrs. Sonia Aneja and Dr. Rashmi Verma. The

students were given eight minutes to present their topic which was followed by an interjection round. In the end the prize winners were awarded prize by Principal, Dr. Kawarjit Kaur.

## POSTER MAKING AND SUDOKU

The department also conducted poster making and sudoku competition on 19th Sepetember, 2016 under Mathemania 2016. There were sixteen teams of two students and eight individual entries that participated in poster making. The time limit for preparing the poster was 1 hour 30 minutes. The judges for the event were - Ms. Gurinderjit Kaur and Dr. Rama Verma.

Poster Making was followed by Sudoku which was conducted in two rounds. The preliminary round had moderately difficult level with the time limit of ten minutes. Whereas, the final round was having high difficulty level and the time limit was fifteen minutes.

After all the competitions were over Principal ma'am, the teachers of the Mathematics department and all the students gathered in the Mata Gujri Hall for the felicitation ceremony. Principal ma'am honoured the office bearers with the badges. Felicitation ceremony was followed by the result declaration and the prize distribution ceremony. Principal ma'am and the teachers presented prizes to the winners of both the competitions. After the prize distribution ceremony was over, Principal ma'am addressed the gathering and appreciated the efforts of all the teachers and the students in making Mathemania 2016 successful. Mrs. Sonia Aneja then presented the vote of thanks which concluded the programme.

## OTHER ACTIVITIES

### TALK BY PROF. V. RAVICHANDRAN

A talk by Prof. V. Ravichandran, Head,

Department of Mathematics, University of Delhi on "e-Learning, Fallacies and Paradoxes in Mathematics". In his talk, he defined and explained statement and paradoxes in Mathematics followed by various examples of paradoxes such as Barber's paradox and Russel's paradox. He also threw a light on difference between Hawler and Fallacy. The range of fallacies in Mathematics encompassed the number system, algebraic equations, integration, binomial theorem and infinite series. He further enlightened the audience with different websites where one can easily refer for books and papers in Mathematics. The talk was very informative and students were greatly inspired and motivated by his talk.

## MATHEMANIA 2015

Asymptote organized its annual event, "Mathemania" on 10th September 2015. Two competitions were held for all the students – the 'Mathematical Rangoli Competition' and the 'Brain Teasers'. The students actively participated in both the competitions. In 'Mathematical Rangoli Competition', the creativity ranged from Mathematics being depicted in the Eiffel Tower to the contributions made by the classic Indian Mathematician-Astronomer, Aryabhatta encompassing various topics like trigonometry, concepts of Pi, quadratic equations and symmetry. A documentary entitled "Decoding the Universe : A Great Maths Mystery" ; published by 'HD Universe Channel' , released on June 12, 2015 , was shown to students to enlighten their minds with the wonders of Mathematics and the crucial role that it plays in every sphere of our life. It was indeed a delightful experience for students.


## LECTURE ON "GAME THEORY IN WIRELESS NETWORK"

A lecture on “Game Theory in Wireless Network” was organized by Asymptote on 4th February 2015. The speaker was Prof. C. S. Lalitha, Associate Professor Department of Mathematics, University of Delhi. The talk began with a brief introduction about the origin of the subject Game Theory. The concept was well explained with examples such as prisoner’s dilemma. She gave a deeper insight into the subject of Game Theory explaining the strategies and tabular form in a game. She also highlighted the Nobel Prize that was awarded to John F. Nash. It was an interactive session with active students’ participation.

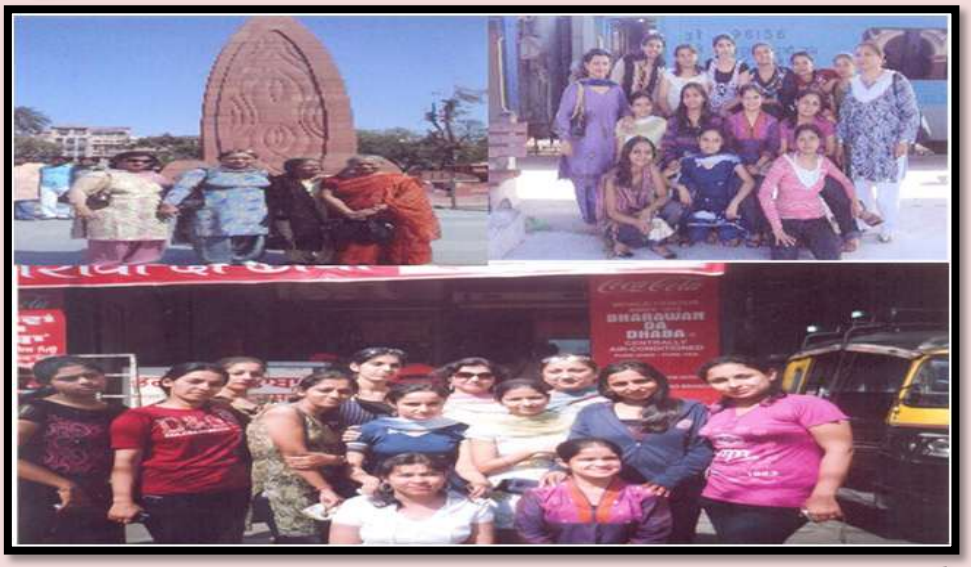
## A TALK BY DR. ASHA GAURI SHANKAR

A talk by Dr. Asha Gauri Shankar entitled "*Fun Frollik And Happy Hours @Maths Play Station*" was organized by the department on January 24, 2007. Both student and faculty gained knowledge through her talk.

## A TALK BY PROF. V. P. SRIVASTAVA

The Head of the Department Prof. V. P. Srivastava enlightened the students and faculty by giving a talk on January 24, 2006.

## FIELD TRIPS


DHARDWAR
DA
DHABA

# ALUMNI SPEAK

**1. Rajni Durga**

**BATCH OF 2014**

They say college life is best phase of one's life. So was my life here at Mata Sundri College for Women. The perfect balance of academics and extra-curricular activities was rightly taught to us here. The amazing faculty of the college had always been there for us all. The bonds built here are for lifetime. I am currently working as citizen service executive at Passport Office Herald House, ITO. I take this opportunity to thank all the teachers who have been an integral part of my life and will always remain close to my heart.

**2) Bableen Kaur**

**BATCH OF 2014**

Being a part of such a prestigious college is something that everybody dreams of. I have been one lucky girl to have been able to live my dream and that too, to the fullest. The Department of Mathematics has been a very respectable department since the beginning. The teachers have always been very helpful on academic as well as personal front. I did post graduation from South Asian University and now I am pursuing Ph.D. from the same institution. It is fascinating to see the improvisation that the college has undergone in terms of the infrastructure. Having studied at an ambience as that of Mata Sundri College has always been captivating.

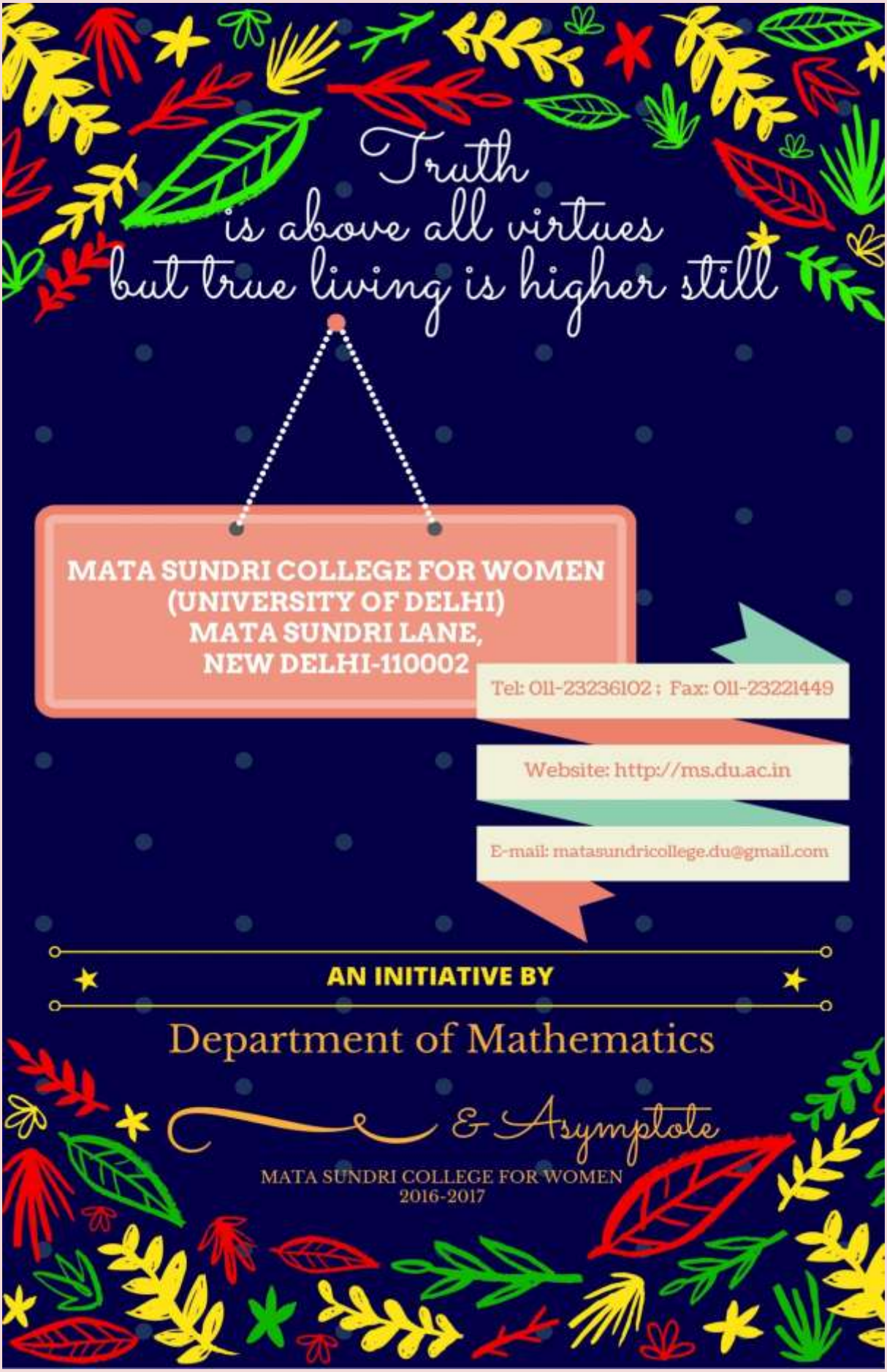
**3) Lovely Jain**

**BATCH OF 2016**

I have been blessed to have studied a course of my choice under the guidance of such brilliant teachers. I am currently placed in 'Xceedence' as an Analyst. I am simultaneously pursuing Acturial Sciences. Years spent at Mata Sundri College will always remain the most amazing part of my life and I will never be able to forget them. This place has given me some of the best people of my life. The friends and not to forget the humble teachers. Along with making personal relations, the professional grooming done here also gave me a sharp edge over other people.

# SOLUTION TO SUDOKU

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


Truth
is above all virtues
but true living is higher still
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Department of Mathematics
& Asymptote
MATA SUNDRI COLLEGE FOR WOMEN
2016-2017