



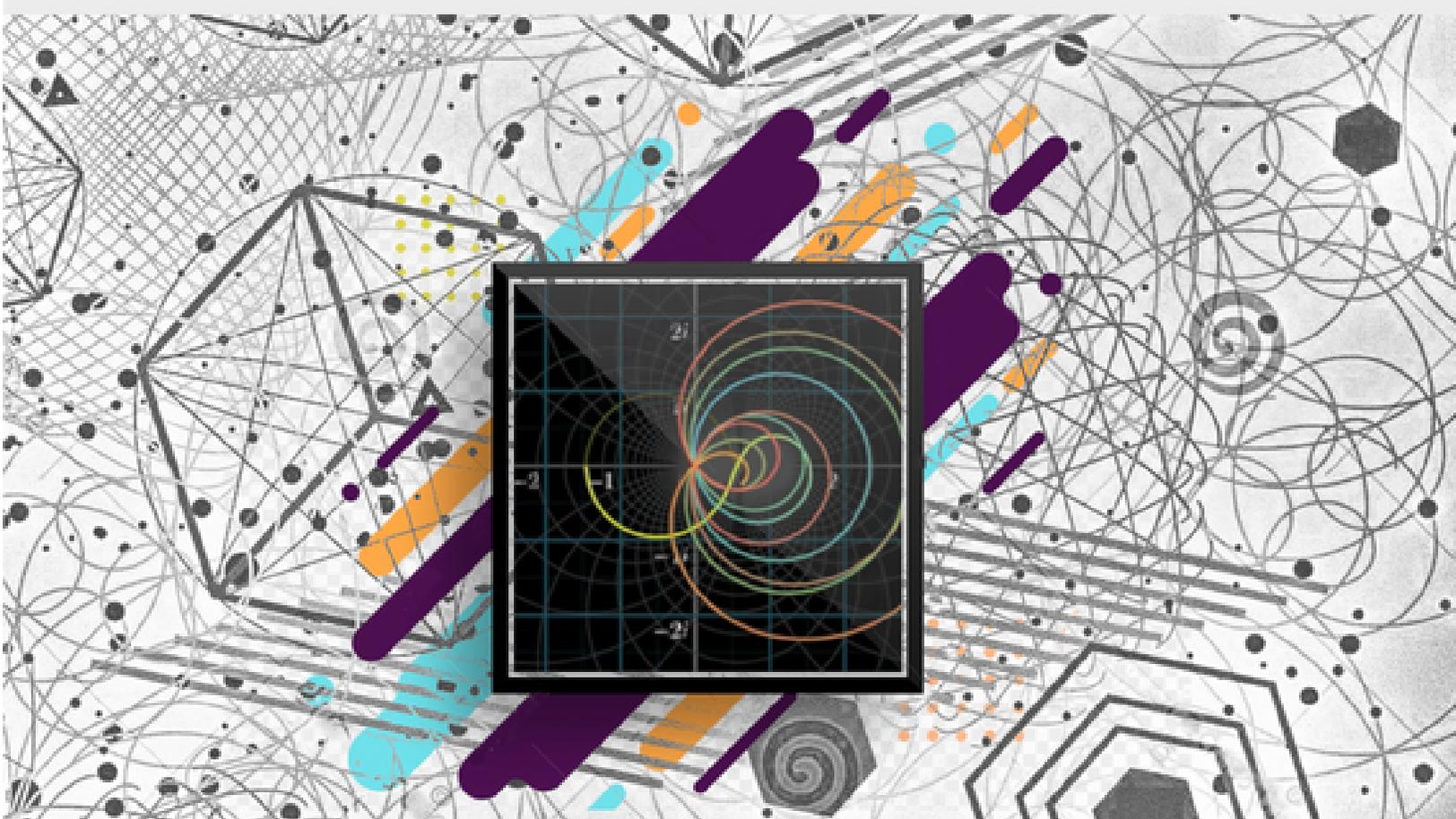
**KESHAV MAHAVIDYALAYA**  
NAAC Accredited Institution "A" Grade  
University of Delhi

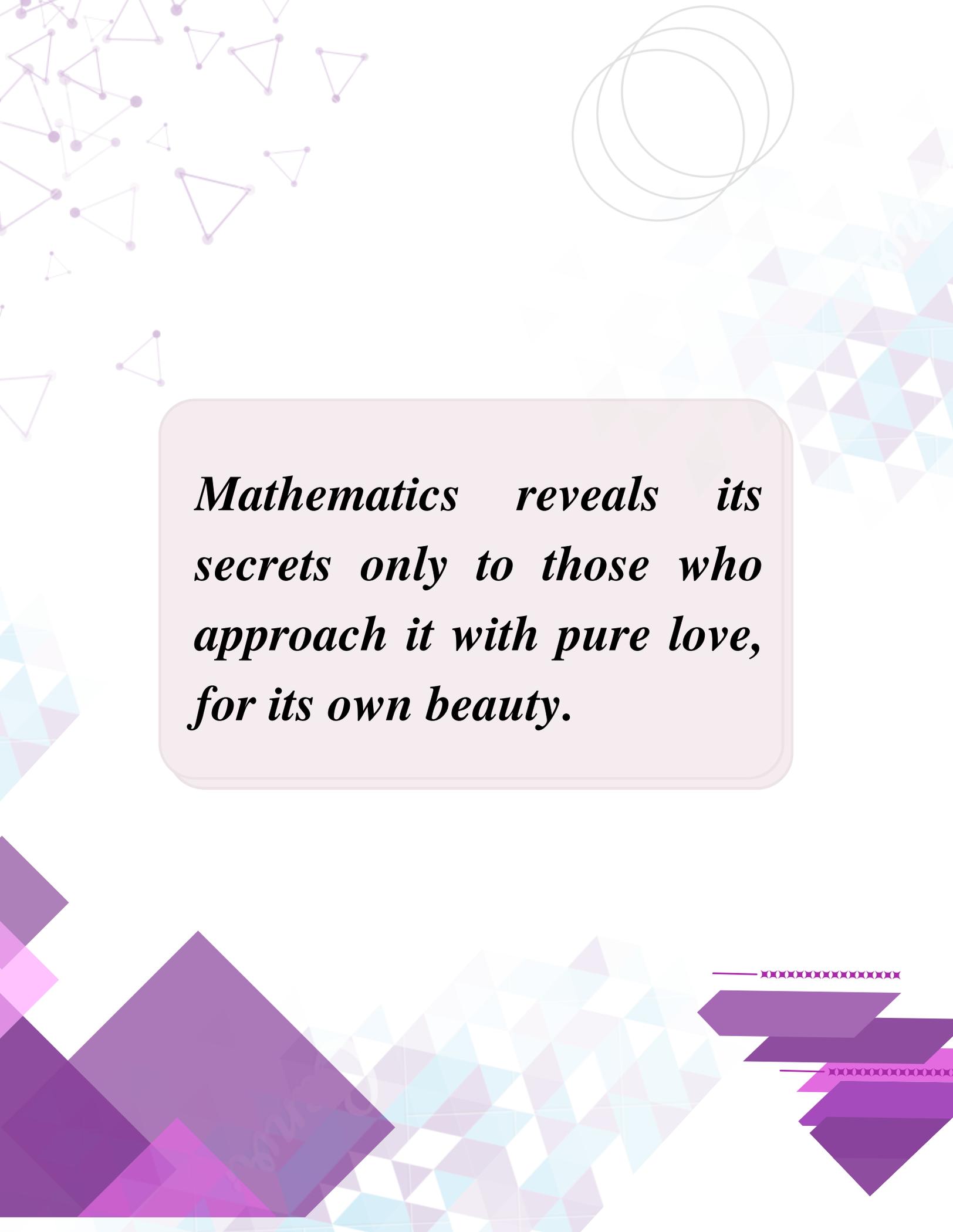


**DEPARTMENT OF MATHEMATICS**

# CONTINUUM

THE ANNUAL MAGAZINE  
2022-23



The background features a complex geometric design. In the top left, there are purple line-art triangles of various sizes. In the top right, there are several overlapping, light grey circles. The right side is dominated by a large, intricate pattern of overlapping triangles in shades of light blue, purple, and white. At the bottom, there are large, solid-colored geometric shapes in shades of purple and magenta, some with decorative horizontal lines and small circles. The central text is contained within a light pink rounded rectangle.

*Mathematics reveals its secrets only to those who approach it with pure love, for its own beauty.*

# MESSAGE FROM THE PRINCIPAL'S DESK

It gives me immense pleasure to share with you the second edition of 'Continuum', the Mathematics Department Magazine. Our mathematics department ensures quality education and holistic development for all the students to nurture them into creative thinkers of tomorrow. The young mathematicians at this institute have a tendency to blend serious contemplation and joyful invention.

Mathematics Department continues to grow, wins accolades and provides its students with a wide and rich variety of invaluable learning experiences. I appreciate the faculty members for assisting the students in all areas of their development and for their guidance in general.

Continuous progress through our combined efforts and objectives helps us to spur higher growth and all-around development. Our students are motivated to work hard and believe in their own limitless learning and achievement potential by the exciting and vibrant environment. Mathematics department gives the students the tools they need to acquire the appropriate aptitude and capabilities by integrating life skills and artistic activities into the curriculum.

This magazine provides engaging, readable and appealing exposition on a variety of mathematical concepts in an appealing manner. This magazine gives students the ideal kind of platform to actively participate in developing their own education.

My sincere appreciation also goes out to the editorial team, whose work has been essential in ensuring that the publication keeps up its high standards. I would like to take this opportunity to thank all the members for their hard work and volunteering their time to help make the second edition of "Continuum" a success.



Prof. Madhu Pruthi  
Principal

# MESSAGE FROM THE VICE-PRINCIPAL'S DESK

*"Learning is a continual process, from the moment we are born until the moment we die."*

It brings me great pleasure to learn that Department of Mathematics, Keshav Mahavidyalaya publishes its annual departmental magazine, 'CONTINUUM'. This magazine endeavors with the significant undertakings the Department accomplished this year.



All the members of Mathematics Department have worked as a team to overcome obstacles in the pursuit of high-quality education. They put a lot of effort into identifying, nurturing, and bringing out the magic and hidden abilities that are dormant in each student. I'm incredibly proud that our students receive the best quality education in our premises.

This magazine is like a mirror that displays the clear picture of all the activities carried out by a department. I congratulate Teacher-in-Charge, faculty members, editorial board and students of the Mathematics Department for bringing this edition of Magazine 2022-23.

Wish you all the best.

**Prof. Kanupriya Goswami**  
Vice-Principal

# MESSAGE FROM THE TEACHER-IN-CHARGE'S DESK

*“There is no end to an education. It is not that you read in a book, pass an examination, and finish with education. The whole of life, from the moment you are born to the moment you die, is a process of learning.”*

-Jiddu Krishnamurti

Education is a fundamental aspect of human life that makes people capable of success. Education is a never ending journey. It is not just about acquiring knowledge, but also about gaining skills, values and compassion that enable us to navigate the challenges of the world around us. It requires hard work and dedication to get everything you can from a good education, the same kind of hard work we have seen in so many students.

An educational institution should foster an environment for learning, not just in the classroom but also outside one. It should inspire creativity, innovation and self expression. This magazine is a testament to the skills of the students and the success of this institution in imparting more than classroom education.

We in Keshav Mahavidyalaya give the opportunity to learn more everyday. All we ask and expect from our students is to keep an open mind even after they graduate and leave this institution, so as to allow themselves to learn. As we believe the greatest failure of mankind would be refusal to change, grow and learn.

The essence of Continuum is innovation, creativity and learning. I am so proud to share that the Department of Mathematics, Keshav Mahavidyalaya, University of Delhi is bringing out the mathematical skills of its students in the second edition of Continuum. I would like to sincerely applaud the editorial board, the faculty and the team of students behind this magazine, it is their hard work that has brought this magazine to its fruition.



**Dr. Rajni Mendiratta**  
Teacher-in-charge

# MESSAGE FROM THE EDITORS' DESK

We are really proud and energized to acclaim the second issue of 'CONTINUUM' the annual magazine of Department of Mathematics. It highlights the pivotal moments of the department's journey of the year throughout. This issue is a treasure trove of articles, poetry, stories, gorgeous images, numerous departmental activities, staff and student accomplishments and departmental events. This collection showcases the authors' analytical thinking skills in addition to their creative abilities.

The year 2022-23 was another fantastic year with our students honoring the department in every possible manner. This magazine is the result of a tremendous amount of hard work by the teachers and students of Mathematics department. We are pretty sure that the readers' minds will be stimulated by the optimistic outlook, diligence, perseverance, and creative ideas displayed by all writers, transporting them to a fantastical realm of unbridled joy and pleasure.

We are incredibly grateful to our Principal, Prof. Madhu Pruthi, and Vice Principal, Prof. Kanupriya Goswami for helping us with our effort to publish the second issue of the magazine. We also appreciate the support of our Teacher in Charge, Dr. Rajni Mendiratta and all our colleagues. We thank all for believing in us. We also appreciate the collaboration and hard work the student members of the editorial team put in to shape this edition of the magazine. It is indeed an honour to congratulate all of them. We genuinely hope that you will enjoy reading it as much as we did to present this edition.



**Prof. Ritu Arora**  
Professor



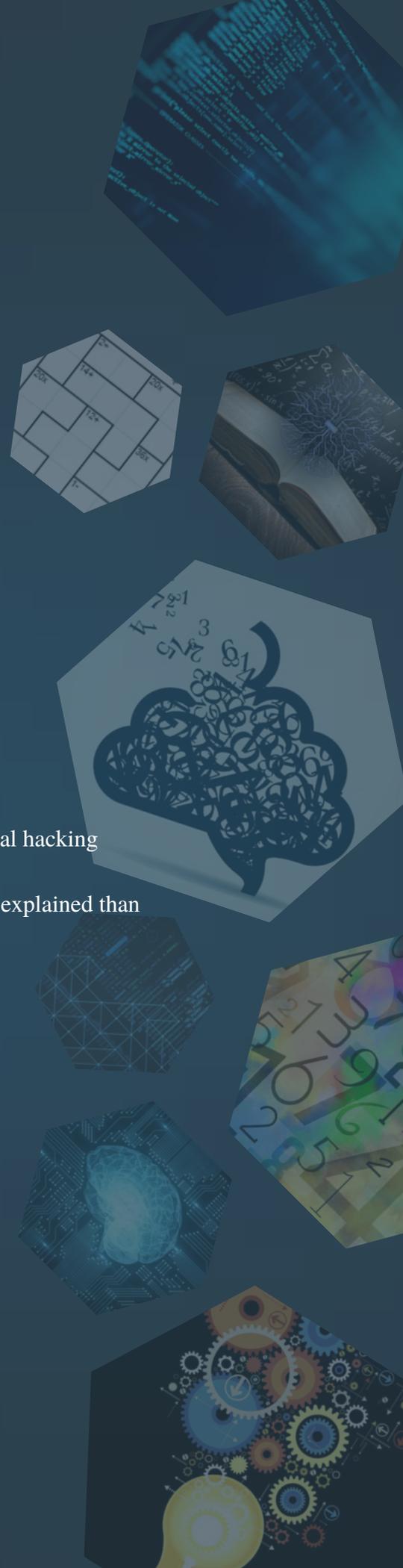
**Dr. Richie Aggarwal**  
Assistant Professor



**Dr. Ram Chander Verma**  
Assistant Professor

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# DEPARTMENT OF MATHEMATICS



Exposure to mathematics provides the ability to develop an analytical approach to real-world situations. The Department of Mathematics of Keshav Mahavidyalaya offers courses namely, B.Sc.(H) Mathematics and B.Sc. Mathematical Sciences mainly and B.Sc. (Prog) Physical Sciences, an interdisciplinary course shared with the Department of Physics and Department of Computer Science. It has highly professional and experienced faculty dedicatedly imparting their knowledge to the students. The eminent teachers of the department handhold the students for better career prospects. The teachers through the mentor-mentee groups make efforts to counsel the students in their family-related problems as well. The Mentor-Mentee program has helped the students, especially during the pandemic time in the last two years.

The department stimulates the understanding of the students through practical education in Information and Communication Technologies (ICT) Lab. The ICT lab sessions are very enriching and thought-provoking in developing the logical and rational thinking of the students. The Department of Mathematics is organizing its annual mathematical meet – Modulus since 2008. During this meet, students along with the faculty members conduct various insightful learning sessions, workshops, and events. The aspiration of this meet is to develop the mind of students in logical and mathematical skills to enhance their thinking and build up their confidence. This inter-college event has a varied range of activities including talks and seminars.

Many students of our college have secured top ranks in the University. They have excelled in different fields and got placements in reputed companies. Many students from our college further opt for master in various prestigious universities in India and abroad.

# WORKSHOP ON FINANCIAL LITERACY

Finance is one of the most crucial part of human life. Thus its proper management is a need of the hour, awareness or which starts at an early stage of life, starting from college life itself.

To focus on this important topic The Mathematics Society, Modulus of Keshav Mahavidyalaya on 21st March 2023, held a 'Workshop on Financial Literacy' as a tool to keep students and teachers sharpen their financial knowledge. We also used our social media handle to spread awareness and sensitise the audience about the same.

The two phase workshop conducted by Citrine Financial Services, Nippon India Mutual Fund, started with warm welcoming of our speaker Mohinder Sharma, who has been working in cooperate sector for 19+ years, who is currently AVP and Zonal training head in Sales and Distribution training Nippon India Mutual Fund.

The speaker then started the first half of the workshop with doubts and questions from the students related to finance sector. He motivates students to stay focused and showed various pathways in which financial stability can be attained and bring a sense of self financial independence to the students. He highlights that focus is the key to define, design and for everything to fall in place. The session was extremely helpful as the speaker told some must remember key points, shared information and experience about benefits of small saving schemes, short and long term marketable fixed instruments, equity and debts, mutual funds etc.

In the second half of the workshop, the speaker elaborated on investment goals and challenges involved in difference between legal heirs and nominees. He made the session attention grabbing with his furnished communication skills and extraordinary sense of humor, ending it on a surprising and crispy note. The workshop ended with the vote of thanks to the guests.



# ECONOMIC COST OF NATURAL DISASTERS

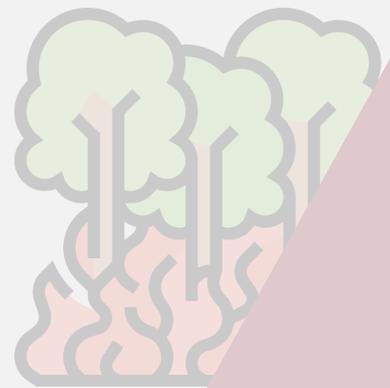
Climate change and unplanned development are causing unprecedented damage to the country. Also, given the unique topographical and socioeconomic conditions of India, it has been heavily prone to natural disasters, which have a long-term and lingering impact on society. India has substantially witnessed severe and frequent cyclones, floods, droughts and earthquakes. 27 out of 36 states and UTs are disaster-prone, 58.6% of the landmass is prone to earthquakes (differing in intensity); 12% of the land is prone to floods and river erosions; 75.8% of the coastline is prone to cyclones and tsunamis; and 68% of the cultivated land is prone to droughts<sup>1</sup>. India ranked 89th out of 181 countries in the Global Risk Index 2020 due to its soaring vulnerability to extreme natural events because of poor preparedness as mentioned in the report. India's performance for strengthening the adaptive capacities also plunged, stating a lack of responsiveness to damages and consequences by associated systems, institutions and other related organizations. The average number of districts affected by cyclones annually has increased from 8 in 2005 to 28 after 2005<sup>2</sup>.

The vulnerability index of Indian states for adaptation planning to the climate reports on 14 indicators are as follows:

- Poverty
- Dependence on natural resources for livelihood
- Proportion of small and marginal
- Lack of coverage of forest per landholders
- Proportion of rainfed agriculture
- Variability of crop yields
- Lack of crop insurance
- Vector- and waterborne diseases
- Poor implementation of MGNREGA
- Lower density of health workers
- Low density of rail+road
- Women's participation in the workforce
- Female literacy rate
- Share of horticulture in agriculture.

## **Effects of climate change on India by 2100**

Over the last few decades, India has witnessed an increase in climate adversity. To account for the climate projections, the Indian government released its first-ever climate change assessment report, which projected the effects of the human-induced climate change in the following aspects by the end of the 21st century:



Warming Indian Ocean and sea Level rise, Tropical Cyclones, Changes in the Himalayas, Rise in Temperature, Changes in Rainfall Droughts

### 01 TEMPERATURE RISE

Over the last few decades, India has witnessed an increase in climate adversity. To account for the climate projections, the Indian government released its first-ever climate change assessment report, which projected the effects of the human-induced climate change in the following aspects by the end of the 21st century.

Average temperature across India is expected to rise by approximately 4.4°C.

- Under an RCP 4.5, the average temperature could rise up to 2.4°C.
- Rise in the temperatures of warmest day and coldest night of the year by 4.7° C and 5.5° C, respectively.
- Frequency of warm days and warm nights is projected to go up by 55% and 70%, respectively.
- 3–4 times higher occurrence of summer heatwaves with a doubled average duration

### 02 CHANGES IN HIMALAYAS

The Hindu Kush Himalayas (HKH) experienced a temperature rise of about 1.3°C during 1951–2014 and a declining trend in snowfall.

- By the end of the 21st century, the annual average surface temperature is projected to rise by 5.2°C under the RCP 8.5 scenario
- The Summer Monsoon precipitation declined by 6% over the period 1951–2015.
- Occurrence of more frequent dry spells; 27% higher during 1981–2011 relative to 1951–1980 and more intense wet spells during summer monsoons.
- Daily precipitation extremes with rainfall intensities exceeding 150 mm per day increased by 75% during 1950–2015

### 03 Changes in rainfall

- The Summer Monsoon precipitation declined by 6% over the period 1951–2015.
- Occurrence of more frequent dry spells; 27% higher during 1981–2011 relative to 1951–1980 and more intense wet spells during summer monsoons.
- Daily precipitation extremes with rainfall intensities exceeding 150 mm per day increased by 75% during 1950–2015.
- The sea-level rise in the North Indian Ocean accelerated from 1.06–1.75 mm per year (1874–2004) to 3.3 mm per year(1993–2017).
- By 2100, sea level in the North Indian Ocean is expected to rise.

### 04 Indian Ocean warming

Sea surface temperature (SST) of the tropical Indian Ocean rose by an average of 1°C during 1951–2015 as compared to the global average SST warming of 0.7°C during the same time period.

- Ocean heat content in the upper 700 m has also increased in the last six decades, with the last two decades showing the steepest rise.

## 05 Tropical cyclones

- Both the spatial extent (up by 1.3% per decade) and the frequency of droughts have increased during 1951–2016.
- Projections signal towards increased frequency with more than two events per decade, intensity and spatial expansion under the RCP 8.5 scenario.

## 06 Droughts

- Both the spatial extent (up by 1.3% per decade) and the frequency of droughts have increased during 1951–2016.
- Projections signal towards increased frequency with more than two events per decade, intensity and spatial expansion under the RCP 8.5 scenario.
- National Electricity Plan(Generation)-(Last amended-2016)
- National mission for electric mobility Plan 2020

## Real Cost of Natural Disaster

Private savings are used up for refurbishment and rehabilitation post-calamity, often out of the funds kept for other purposes, reversing economic and social progress. It also affects the ability of the poor to climb the income ladder and passes the vicious cycle of social and educational backwardness through generations due to poor socioeconomic base.

Natural catastrophes disrupt business operations by disrupting transaction channels (for the elements of business: sale, production and finance) and capital. As bad debts increase, the cost to avail credit increases and consumption patterns plunge, leading to a slow recovery. Recovery from natural catastrophes can be delayed due to the unavailability of funds and investments by worsened credit ratings. This phenomenon is more apparent in low-income developing countries. Although credit ratings are changed due to many explicit or implicit factors arising out of natural catastrophes, the prevailing uncertainty and future expectations of additional damages may be contributing factors to their degradation. Following the 2013 Kedarnath floods, the loan growth rate in Uttarakhand increased from 25% in 2013 to 35% in 2014. However, loan growth declined to less than 5% in the next financial year. Although bad loans remained constant, the ratio of bad loans to total loans decreased by 0.5 percentage points to 1% (could be due to the increase in loans) and then jumped to 2.2% in the next fiscal year. Concentrated business operations of banks in the given region and loans in priority sectors increase the 'portfolio at risk' for banks. For example, Federal Bank derived 34% loans and the South Indian Bank derived 41% of loans from Kerala at the time of floods in 2018.

## **Conclusion**

Natural disasters can now be termed man-made disasters as we have prioritized growth over development. The traditional way of calculating the cost of natural disasters needs to be relooked. In my view, besides direct and indirect costs, we need to look at multidimensional costs and intergenerational impact of natural disasters, which should include stagnation cost, opportunity cost, temporary or short-term impact, and long-term or permanent impact. The new method of calculating the cost of natural disasters will imply that disaster mitigation should be prioritized over disaster management.

Dr. Rubina Mittal

# Introduction to Machine Learning

Machine learning is a subfield of artificial intelligence that focuses on the development of algorithms and statistical models that allow computers to perform tasks without explicit programming. These tasks can include pattern recognition, prediction, and decision-making, and are accomplished by learning from data, either by finding patterns in the data or by using a set of rules specified by the programmer.

Every Machine algorithm has three components:

- i. Representation
- ii. Evaluation
- iii. Optimization

Steps Involved in Machine learning

1. Gathering Data
2. Preparing that data
3. Choosing a model
4. Training
5. Evaluation
6. Hyperparameter Tuning
7. Prediction

Five main mathematical areas that are used in Machine Learning techniques:

1. Multivariate Calculus
2. Mathematical Analysis: Derivatives and Gradients
3. Probability theory and statistics
4. Linear algebra for data analysis: Scalars, Vectors, Matrices, and Tensors
5. Algorithms and Complex Optimizations

There are many statistical models developed in Machine learning such as

1. Linear Regression
2. Graphical Models i.e. Naive Bayes
3. K-Nearest Neighbours (KNN)
4. Decision Trees
5. Random Forest
6. Support Vector Machines (SVM)
7. Logistic Regression
8. Neural Networks
9. Principal Component Analysis (PCA)
10. Convex Optimization i.e. Gradient Descent
11. Combinatorial Optimization i.e. Greedy search algorithm

Types of machine learning

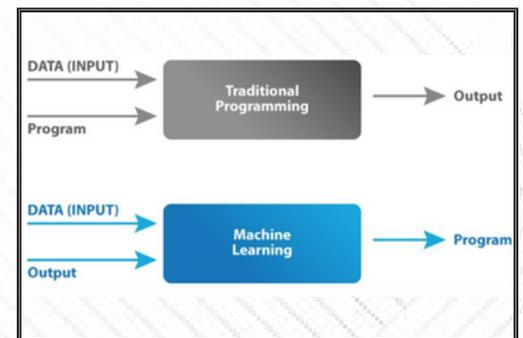
1. *Supervised learning*: It involves supervision, where machines are trained on labeled datasets and enabled to predict outputs based on the provided training. The labeled dataset specifies that some input and output parameters are already mapped. Hence, the machine is trained with the input and corresponding output. A device is made to predict the outcome using the test dataset in subsequent phases

2. *Unsupervised learning*: It refers to a learning technique that's devoid of supervision. Here, the machine is trained using an unlabeled dataset and is enabled to predict the output without any supervision. An unsupervised learning algorithm aims to group the unsorted dataset based on the input's similarities, differences, and patterns.

3. *Reinforcement learning*: This is a feedback-based process. Here, the AI component automatically takes stock of its surroundings by the hit & trial method, takes action, learns from experiences, and improves performance. The component is rewarded for each good action and penalized for every wrong move. Thus, the reinforcement learning component aims to maximize the rewards by performing good actions.

Applications of Machine learning in real-world

1. Finance sector
2. Healthcare Industry
3. Retail Sector
4. Social media
5. Travel Sector
6. Automatic speech recognition



# Boltzmann prize Winner: Prof. Deepak Dhar

Prof. Dhar completed his B.Sc. degree programme as a National Science Talent Search (NSTS) scholar from Allahabad University (AU). As a college student, he enjoyed working out straightforward mathematical puzzles he came across in publications. He later rose to prominence as one of India's leading theoretical physicists, making significant contributions to the study of statistical mechanics. He proceeded from AU to IIT Kanpur (IITK) to pursue a master's degree in Physics, when he met several peers who were enthusiastic about starting academic careers. He chose the California Institute of Technology (Caltech), in the USA, for his Doctorate after completing his Master's degree at IITK. Presently, he holds a distinguished professorship at the Pune location of the Indian Institute of Science Education and Research (IISER), in the department of physics.

He received the TWAS (The World Academy of Sciences) medal in 2002, which is given to scientists from underdeveloped nations who have made remarkable contributions to science. For his contributions to physical sciences, he was also given the 1991 Shanti Swarup Bhatnagar Award for Science and Technology, one of the highest science honours in India.

Prof. Dhar's area of interest are phase transitions in hard core models, percolation theory, application of statistical physics techniques to interdisciplinary problems. His work's on amusing mathematical puzzles printed in Sunday supplements, marked the beginning of his voyage into statistical mechanics. He claims that completing the puzzles taught him new mathematical concepts and provided the solutions to several challenging mathematical problems. Understanding how macroscopic qualities develop from a vast number of simpler items is the focus of his research. For instance, a large mound of sand is affected by the straightforward rule that a few sand particles will tumble when put together. These basic models serve as guides for understanding how complicated qualities manifest themselves in common place objects.

Prof. Dhar said in an interview that "Many difficulties in mathematics have been described in the form of easy puzzles." Yet, when you continue to work on them, sometimes the answers signal the start of resolving more complicated issues. According to him, 'In the beginning of the journey, you don't know what relevance such answers may have.' He mentioned Ramanujan as one of the best mathematicians. It's always great that Prof. Dhar's precious work has been recognized in the whole world and he made every Indian proud by his research. Prof. Dhar's work in theoretical physics earned him numerous honours this year, including the Padma Bhushan.

Prof. Ritu Arora  
Dr. Richie Aggarwal

# Fields Medal Winner: June Huh

June Huh, 39, has been awarded with the Fields space Medal, the highest honor in mathematics, for his ability to wander through mathematical landscapes and find just the right objects - objects he then uses to bring the seemingly disparate fields of geometry and combinatorics into conversation with each other in new and exciting ways. Since graduating, he has solved several major problems in combinatorics, taking a circuitous route through other areas of mathematics to get to the core of each proof.



Source : Internet

According to Huh, finding a new path resembles a "little miracle." The same could be said of his path into mathematics itself that it was marked by many aberrations and a series of small miracles. When he was younger, Huh had no desire to become a mathematician. He was indifferent to the subject, and dropped out of high school to become a poet. It was only a chance encounter during his university years and many moments of being lost - that brought him to the realization that mathematics contained what he had been searching for all along.

He was born in 1983 in California, where his parents were finishing their studies. The family then moved to Seoul, South Korea, when Huh was about 2 years old. There, his father taught statistics and his mother taught Russian language and literature. He loved to learn and he preferred to read on his own. In elementary school, he devoured all 10 volumes of an encyclopedia on living things.

When he was 16 years old and in the middle of his first year in high school (which lasts for three years in South Korea), he decided to drop out to write poetry. He was something of a romantic. He got emotional after listening to good music. He wrote about nature and about his own experiences. He planned to complete his masterpiece in the two years before he'd have to attend university.

He developed mathematical breakthroughs as a result of that poetic detour. His artistry is evident in how he uncovers the just-right objects at the heart of his work, and in his quest for deeper significance in everything he creates.

Federico Ardila-Mantilla, a mathematician at San Francisco State University and one of Huh's collaborators states that "Mathematicians are a lot like artists, looking for beauty, but I think it's very pronounced in his case. And I just really like his taste. Beautiful things are made by him."

## An Unexpected Discovery

Huh submitted applications to around a dozen doctoral programs in U.S. But all of them turned him down due to his unremarkable undergraduate experience except one. He started his academic career at the University of Illinois, Urbana-Champaign, in 2009, and transferred to the University of Michigan to finish his doctoral degree in 2011.

Huh treasured his graduate school experiences despite the difficulties. He was immediately noticeable. He proved a 40-year-old graph theory conjecture as a first-year graduate student in Illinois. The problem, known as Read's conjecture, concerned polynomials, such as;  $n^4 + 5n^3 + 6n^2 + 3n + 1$ , related to graphs, which are collection of vertices (points) connected by edges (lines). For example, imagine that you wish to color a graph's vertices so that no two neighboring vertices have the same color. There are numerous ways to color the graph when you have a set number of colors at your disposal. It turns out that the chromatic equation can be used to get the total number of possibilities (which is written in terms of the number of colors being used). Mathematicians noticed that the coefficients of chromatic polynomials always appeared to follow specific patterns, regardless of the graph. They increase and subsequently drop because they are unimodal in the beginning. Consider the polynomial from the preceding case. A unimodal sequence is formed by the absolute values of its coefficients, which are 1, 5, 6, 3, 1. Also, this sequence is called "log concave." The square of the center number for any three successive numbers in the sequence is at least as large as the product of the numbers on either side of it. (For instance,  $36 \geq 5 \times 3$  in the polynomial mentioned above).

**This is how a confused individual who dropped out of school rose to become a superb mathematician.**

Dr. Richie Aggarwal

Prof. Ritu Arora

## Calcudoku

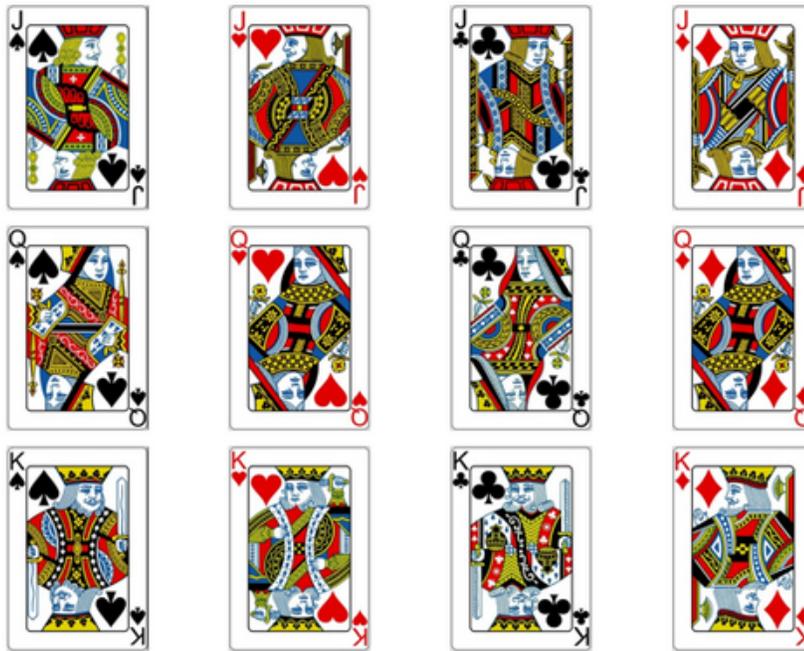
Rules of the game:

- Place the numbers 1-6 once in each row and column of the grid...
- Bold lined regions contain a number and mathematical operation (addition, subtraction, multiplication)...
- With subtraction sums, you must subtract the smallest number from the larger number in the bold lined region.

						+	-	x	÷
1-	2+		20x						
	14+								
20x		12+			36x				
15x				1-					

Answer in page number - 34

# SOME INTERESTING FACTS RELATED TO PLAYING CARDS



- The Jack of Spades (J ♠), Jack of Hearts (J ♥) and King of Diamonds (K ♦) are shown as seen from one side, while the rest of the court cards are shown in full face. These cards are commonly called **one-eyed**.
- The King of Hearts (K ♥) is the only King with no moustache. He is also shown with a sword behind his head, making him appear to be stabbing himself. This leads to the nickname **suicide king**. It can also be thought as if he is hiding the sword behind him. This and his missing moustache have led him to be named **the false king**.
- The King of Diamonds (K ♦) is traditionally armed with an axe, while the other kings are armed with swords. That is why, he is sometimes referred to as **the man with the axe**. The axe held by him is behind his head with the blade facing towards him.
- The Ace of Spades (A ♠) is sometimes called **death card** because of its unique large ornate (i.e., decorated) spade (a sharp-edged metal blade with long handle).
- The Queen of Spades (Q ♠) usually holds a sceptre (a kind of stick held at the crowning ceremony) and is sometimes known as **the bedpost queen**. More often, she is called **the black lady**.
- All Queens are depicted with a flower styled according to their suit.



$\pi$  in Bible

The Bible contains a verse that tells us a value of  $\pi$  that was used.

“And he made a molten sea, ten cubits from the one brim to the other: it was round all about, and its height was five cubits: and a line of thirty cubits did compass it about” (I Kings 7, 23; II Chronicles 4, 2.)

It can be translated as

“He made the Sea of cast metal, circular in shape, measuring ten cubits from rim to rim and five cubits high. It took a line of thirty cubits to measure around it.”

It means the diameter is 10 units and circumference is 30 units. So,  $\pi \approx 3$ . The cubit is an ancient unit based on the forearm length from the middle finger tip to the elbow bottom. Lengths ranged between 38 to 51.8 cm (15.0 to 20.4 in) during the ancient Egyptian to Roman empires.

### Some Approximations of $\pi$

Name/Country	Approximation
Apollonius (250-175 B.C.)	$\pi \approx 3.1416$
Claudius Ptolemy (100-178 A.D.)	$\pi \approx \frac{377}{120} = 3.141666666\dots$
Rome	$\pi \approx \frac{25}{8}$
China (before 100 B.C.)	$\pi \approx 3$ and $\pi \approx \sqrt{10}$
China (5 <sup>th</sup> Century)	$\pi \approx \frac{22}{7}$ and $\pi \approx \frac{355}{113}$
Aryabhata (500 A.D.)	$\pi \approx 3.1416$
Al-Khwarizmi (833 A.D.)	$\pi \approx 3.1416$
Al-Kashi (1436)	$2\pi \approx 6.2831853071795865$

### GUINNESS World Record with $\pi$

The most decimal places of Pi memorized is 70,000, and was achieved by Rajveer Meena (India) at the VIT University, Vellore, India, on 21 March 2015. Rajveer wore a blindfold throughout the entire recall, which took nearly 10 hours.

**Do You also want to Memorize some digits of  $\pi$ ? Here are the tricks!!!**

#### 1. Use the phonetic code

1	2	3	4	5	6	7	8	9	0
t or d	n	m	r	L	j, ch, sh	k, hard g	f, v	p, b	s, z

Memorize the following sentence that gives first 24 digits of  $\pi$ :

**“My turtle Pancho will, my love, pick up my new mover, Ginger.”**

**3 1 4 1 5 9 2 6 5 3 5 8 9 7 9 3 2 3 8 4 6 2 6 4**

Next 17 digits correspond to “My movie monkey plays in a favorite bucket.”

Next 19 digits correspond to “Ship my puppy Michael to Sullivan’s back-rubber.”

Next 18 digits correspond to “A really open music video cheers Jenny F. Jones.”

Next 22 digits correspond to “Have a baby fish knife so Marvin will marinate the goose chick.”

2. Count the number of letters in the words.

Memorize the following sentence that gives first 15 digits of  $\pi$ .

*“How I want a drink, alcoholic of course, after the heavy chapters involving quantum mechanics.”*

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

Michael Keith rewrote Edgar Allen Poe’s poem *The Raven* to turn it into a mnemonic for pi.

The number of letters in most words encodes a digit of pi. Words with 10 letters encode a zero. Words with more than 10 letters encode two consecutive digits of pi. The poem encodes the first 740 digits of pi. The full poem has 18 stanzas. Here I include only the first and last.

Poe, E.

Near a Raven

Midnights so dreary, tired and weary,  
Silently pondering volumes extolling all by-now obsolete lore,  
During my rather long nap — the weirdest tap!  
An ominous vibrating sound disturbing my chamber’s antedoor.  
“This,” I whispered quietly, “I ignore.”

...

So he sitteth, observing always, perching ominously on these doorways.  
Squatting on the stony bust so untroubled, O therefore.  
Suffering stark raven’s conversings, I am so condemned, subserving,  
To a nightmare cursed, containing miseries galore.  
Thus henceforth, I’ll rise (from a darkness, a grave) — nevermore!

The story of Pi is still very far from getting over. But I shall conclude by telling you something interesting, viz.,  $\pi$  **day**.

People have become so enthusiastic about  $\pi$  that people often with tongue-in-cheek—or maybe pi in their cheek—will celebrate  $\pi$  in some fun ways. For instance, I’ve taken part in many celebrations of  $\pi$  on what’s called  $\pi$  day. And  $\pi$  day, because of the digits of  $\pi$ , is celebrated on March 14. That’s 3/14 at 1:59, so you have 314159.

Dr.Ashish Bansal

# MATHEMATICS

Mathematics is the science that deals with the logic of shape, quantity and arrangement. Math is all around us, in everything we do. It is the building block for everything in our daily life, including mobile devices, computers, software, art, money, engineering and even sports.

Mathematics is a critical tool in the modern world. It is used in commerce, engineering, science, and many other fields. It is also used in everyday life, from basic addition and subtraction to more complex concepts like calculus and algebra. Learning mathematics can have a number of benefits, both in school and in the real world. Many of the problems we face in the world today require a deep understanding of mathematics.

One of the biggest benefits of learning mathematics is that it can help you improve your problem-solving skills. Many real-world problems can be solved using mathematical concepts, so being able to understand and work with these concepts can be extremely helpful. Additionally, learning mathematics can also help you develop critical thinking and reasoning skills. Being able to think logically and break down problems into smaller pieces is a valuable skill that can be applied in many different situations.

Another benefit of learning mathematics is that it can help you boost your career prospects. Many jobs require at least some understanding of mathematics, and having strong math skills can give you an advantage over other candidates. In particular, jobs in fields like finance, engineering, and science often require strong math skills.

Unfortunately, many students do not learn mathematics properly and as a result, they struggle in their studies and careers. There are many consequences of not learning mathematics. For example, students may not be able to understand scientific concepts or solve problems in their chosen field. This can lead to frustration and even depression. In addition, people who cannot do basic mathematics often earn less money than those who are competent in the subject.

Mathematics also develops concentration and discipline. It can be difficult to master, but the rewards are well worth the effort. There is a great deal of satisfaction that comes from solving complex mathematical problems. It is a mentally stimulating activity that can be enjoyed by people of all ages.

So therefore I love mathematics and I hope all of you too love mathematics.

Dr. Panjabi Singh

# How Big is the Set of Rational Numbers?

A question is meaningless if the terms used are not clearly defined. If somebody asks how big a thing is, then the immediate question that you might need to ask back is to define the term 'big'. Usually, in real life situations, the meaning of the word may be apparent from the context. For example, a person asking 'how big a bank is?' is not expecting an answer in terms of length\*width\*height of a building. When we talk about the size of a set, for example, a subset of the real line, it can be interpreted in different ways. An immediate interpretation is in terms of the number of elements in the set, i.e., the cardinality of the set. A big set is supposed to have a bigger cardinality; a set with 5 elements is certainly bigger than a set with 3 or 4 elements. However, once we reach infinity, the tools to distinguish become limited. In terms of cardinality, we can't say if the set of rational numbers is any bigger than the set of natural numbers or the set of integers as all three of them have the same cardinality, countably infinite. An uncountably infinite set may be certainly considered as bigger than a countably infinite set; that makes the set of irrational numbers bigger than the set of rationals.

Another way to talk about the size is in terms of how thick or how dense the set is in its parent set. One can barely find an integer on the real line, whereas there are infinitely many rational numbers inside any small interval of positive length. In that sense, the set of rational numbers is (topologically) bigger than the set of integers even though both have the same cardinality.

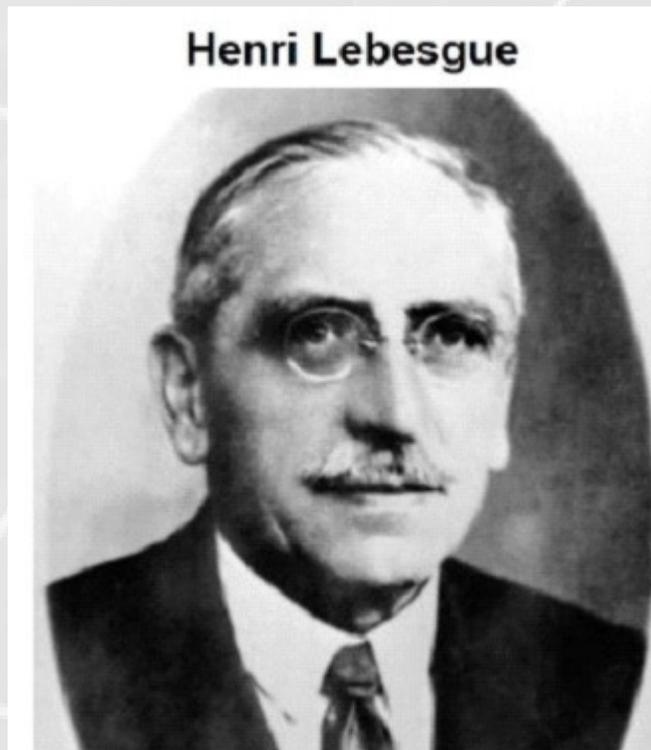
In both the instances we saw above, we never considered the size of a set in its purest form as its length on the real line. An interval  $I$  of the form  $[a, b]$  or  $(a, b)$  or  $[a, b)$  or  $(a, b]$  with  $a < b$ , can be considered to have a length  $b - a$  units. Naturally, a disjoint union of two intervals must have length as sum of lengths of the individual intervals. We can even extend this to an infinite pairwise disjoint union of intervals. For example,  $\sum_{n=1}^{\infty} \frac{1}{2^n}$  is supposed to have a length of 1 unit. Note that we can't have an uncountable number of pairwise disjoint intervals of positive length (why?), making it always a countably infinite sum of non-negative real numbers, which we can manage with the elementary idea of summing up an infinite series through sequence of its partial sums.

Now the question is to extend this notion of the length of an interval to arbitrary subsets of the real line. Since our aim is to give a meaning to measuring the size of a subset  $A$ , let us denote it by  $m(A)$ , and refer to it as the measure of  $A$ . The basic idea behind defining that is to observe that if  $A$  is a subset of an interval  $I$ , then the measure of  $A$  is supposed to be smaller than the length of the interval  $I$ .

Moreover, if  $A$  is a subset of a union of (possibly infinitely many) intervals, then the measure of  $A$  must be smaller than the sum of lengths of the intervals. In other words, if  $A \subset \bigcup_{i=1}^{\infty} I_i$ , then  $m(A) \leq \sum_{i=1}^{\infty} m(I_i)$ . In order to formalize our definition, let us work only with intervals of the form  $[a, b)$ , i.e., left-closed right-open intervals. The above discussion gives us all rights to conclude our formal definition as follows. For  $E \subset \mathbb{R}$ , define  $m^*(E)$ , where for some  $\epsilon > 0$  with

Since we're taking the infimum over a subset of non-negative real numbers, clearly  $m^*(E) \geq 0$  for any  $E$ . Let's first calculate  $m^*(\mathbb{R})$ . We can easily see that given any  $\epsilon > 0$ , the sequence of intervals, given by  $I_n = [n, n + \epsilon)$ , satisfies  $\bigcup_{n=1}^{\infty} I_n \subset \mathbb{R}$ , and hence  $m^*(\mathbb{R}) \leq \sum_{n=1}^{\infty} m(I_n) = \sum_{n=1}^{\infty} \epsilon = \epsilon$ . Thus for any  $\epsilon > 0$ , meaning that  $m^*(\mathbb{R}) = 0$ . Now, what about  $\mathbb{Q}$ ? We may feel that, since  $\mathbb{Q}$  is dense in  $\mathbb{R}$ , a sequence of intervals that covers  $\mathbb{Q}$  may also cover whole real line. That's not the case. This is highly counterintuitive. After all,  $\mathbb{Q}$  is just a countable set. Take a counting of  $\mathbb{Q}$  as  $\{q_1, q_2, \dots\}$ . Then  $\bigcup_{n=1}^{\infty} [q_n, q_n + \epsilon/2^n)$ , given by  $I_n$ , covers  $\mathbb{Q}$ . Arguing as in the case of  $\mathbb{R}$ , we get  $m^*(\mathbb{Q}) \leq \sum_{n=1}^{\infty} \epsilon/2^n = \epsilon$ . Thus, even though  $\mathbb{Q}$  is a dense infinite subset of  $\mathbb{R}$ , measure theoretically, it's a very small set, a measure zero set.

The measure defined above is known as the Lebesgue outer measure, named after the French mathematician Henri Leon Lebesgue (1875-1941). You will learn more about Lebesgue measure and Lebesgue integration that generalizes Riemann integration in your Masters. There's a famous quote that is attributed to him which is an important remedy for us teachers: "The only teaching that a professor can give, in my opinion, is that of thinking in front of his students."



**Henri Lebesgue**

Dr. Janson Antony A

# Paradoxes in Mathematics

Paradox : A situation in which two mutual contradictory statements are demonstrated, each one having been deduced by means that are convincing from the point of view of the same theory.

Here in this note, I am going to discuss some very famous paradoxes in the field of mathematics.

“Achilles and the tortoise”

This paradox deals with the contradiction involved in certain attributes of motion and may be stated as follows:

A runner (Achilles) is standing at a point A and a tortoise is standing at a point B 100 meters away from A. At the same moment of time Achilles begins to run from A towards B, while the tortoise begins to move away from B in the direction away from A at a speed which is say, 100 times less than that of Achilles. Experience teaches us that in such a situation Achilles will overtake the tortoise after a fairly short period of time. On the other hand it is also possible to conclude that Achilles will never overtake the tortoise and will not even reach the point B. In fact, at the moment when Achilles has reached the mid point  $L_1$  of the distance AB, the tortoise will have moved away from B through only a short distance. Next Achilles will reach the mid point  $C_2$  of  $C_1B$ , then the midpoint  $C_3$  of  $C_2B$ , etc.

Throughout that time the tortoise keeps moving away from B. In order to reach B, Achilles must have been present at each point in the infinite sequence of point  $C_1, C_2, \dots$ . However, it is impossible to be present at an infinite

Therefore, Achilles will never arrive at the point B and will never overtake the tortoise.

Russell's paradox

Consider the following property D of sets. Assume that a set X has the property D if and only if it is not an element of itself.

Property D is valid for a very large majority of specific sets used in mathematical considerations, e.g., neither the set of natural numbers nor the set of real numbers are elements of themselves.

Consider the set T such that its elements are exactly those sets X that have property D. Now, consider whether T belongs to T or T does not belong to T is true. If T belongs to T then by definition, T has the property D, i.e., T does not belong to T. Thus, one must postulate T does not belong to T. But this again results in a contradiction, since if T does not belong to T, T has property D so that T belongs to T.

The paradox of a village barber : A variant of Russell's paradox

It is the case of village barber who shaves those and those inhabitants of his village who do not shave themselves. Does the barber shave himself ?

A reason similar to that given in the context of Russell's shows that he both shaves and does not shave himself .

This difficulty is easily overcome if one concludes that there cannot be such a barber. The condition to be satisfied by a barber is self-contradictory and therefore cannot be satisfied.

Conantor's paradox:

Let  $M$  be the set of all sets and let  $P(M)$  be the set of all its subsets. It is clear from the definition of  $M$  that  $P(M)$  is included in  $M$ . On the other hand, in accordance with a well-known theorem of Cantor, the cardinality of  $P(M)$  cannot be a subset of  $M$ .

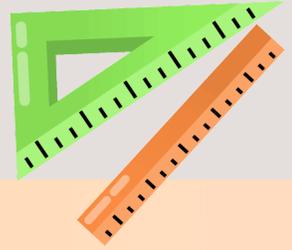
There are a number of such paradoxes which help in creating various foundations in the field of mathematics. Indeed, paradoxes are interesting in creating but they are equally beautiful in their clarity of a particular subject.

Mr. Ankit Kumar

## FUN FACTS

- The number pi ( $\pi$ ) has an infinite number of decimal places, but it starts with 3.14.
- Zero (0) was invented in ancient India, and it spread to the rest of the world through the Arab traders.
- The first recorded mathematical proof is found in ancient Babylon and is over 4000 years old.
- Mathematician Carl Friedrich Gauss made significant contributions to number theory, statistics, and astronomy, but he also discovered that every positive integer is representable as a sum of at most three triangular numbers.
- The shortest mathematical joke is the number 0.079. It's a "micro humor" joke because it's so small.
- Mathematician John Horton Conway created a cellular automaton called "Conway's Game of Life" which simulates the birth and death of cells in a grid.
- A perfect number is a positive integer that is equal to the sum of its positive divisors, excluding the number itself. For example, 6 is a perfect number because its divisors are 1, 2, and 3, and  $1 + 2 + 3 = 6$ .
- The study of cryptography, or secret writing, is closely related to mathematics, particularly number theory.
- The most famous equation in mathematics is probably Albert Einstein's  $E=mc^2$ , which states that energy and mass are interchangeable.
- The longest mathematical proof ever published is over 13,000 pages long and was published in 2005.

# VEDIC MATHEMATICS



## *General Case Integer Subtraction Using Vedic Mathematics*

Vedic Mathematics is a holistic, coherent, and unified system of Mathematics. With the system of Vedic Mathematics, subtraction can be done with a much simpler, easier, and more creative method. This article shows the firepower of the sutras All from Nine and the Last from Ten for the General Case Arithmetic Subtraction. The Vedic Method, with the use of Bar Numbers, will take you away from the unnecessary steps, and will make Subtraction easier, faster, and more creative.

The Vedic Method, All from Nine and The Last from Ten

Using the sutra Nikhilam Navatascaraman Dasatah, that is, All from Nine and the Last from Ten, What we do is understand that all digits are all from 9 except the last nonzero number which will be from 10.

Case I. With Base Numbers

Case I.(a) With Perfect Base Numbers

example,  $10,000 - 3,579$ .

We first see that the minuend has all zeroes except in the highest place value, in this example, the ten thousand's place. If we will have this, then we can apply the sutra. Using the sutra, we will think of a number that when we will add it a certain number on a specific place digit, the sum will be 9 (All from 9), hence giving us 6 with 3, 4 with 5, and 2 with 7. Then we have  $10,000 - 3579 = 642$ . Then, we can see that 9 is the last nonzero number, that is, the one's digit, so we will find a number that we will add to it, such that the sum is 10 (the Last from 10), which is 1. Hence, we have  $10,000 - 3579 = 6421$ . Giving us our answer without any borrowing or taking away numbers.

Case I.(b) With Sub Base Numbers

example,  $50,000 - 3,579$ .

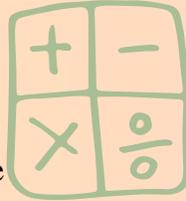
The only difference of this example from the one above is that the highest place value, which is 5 in the ten thousand's place. We will use a similar procedure as above, but we will need to deduct 1 from the highest place value, that is,  $5 - 1 = 4$ . Hence, we have  $50,000 - 3579 = 46421$ .

Bar Numbers

We need to use Bar Numbers in order for us to arrive at the General Case Arithmetic Subtraction. Recall that numbers, such as, 59, 38, and 87 can be represented as 61, 42, and 93, respectively.

Case II. General Case Arithmetic Subtraction

In Arithmetic, where we all use positive integers, we have a Vedic method with the use of Bar Numbers to do subtraction in a General Case in Arithmetic. For instance, consider  $589,813 - 253,987$ . When the the digit in the minuend is greater than the digit in the subtrahend, then we subtract normally.



When the digit in the subtrahend is greater than the digit in the minuend, then we subtract the minuend from the subtrahend and install a bar in that specific place digit. Observe that we have  $589,813-253,987=336$ ,. What we will do then is to get rid of the Bar Numbers and convert them into normal or ordinary numbers. We will be using the sutra All from Nine and The Last from Ten in converting Bar Numbers back to normal numbers. Hence, we have  $336 = 335,826$ . Therefore,  $589,813-253,987=336$ , is  $335,826$ .

Hoping that this Vedic Method of Subtraction can reach our primary and middle schools so that pupils can also develop a holistic approach in Mathematics, especially in Subtraction.

Mr. Deepak Kumar Meena

## THE STORY OF 0!

Maths - an incredible tale of numbers full of thrilling combinations, engrossing ideas, and musing questions. I accept Maths is holding since it uncovers its cards out of the blue. I learned the story of 0! just recently. Even though it might not sound very appealing to math experts who are reading this, I was completely enamored of math once more when I answered this seemingly straightforward question. So this exclamation looking symbol is a Mathematical operation factorial which means to multiply a series of descending natural numbers.

For example,

$$3! = 3*2*1=6$$

Now we take it as a fact that  $0! =1$  but what's funny is that how can we decrease a number till 1 which is already less than 1. So to decode this cipher let us all do a mental exercise. So let's calculate what is  $4!$ ,  $3!$ ,  $2!$ ,  $1!$

So,

$$4! = 4*3*2*1 = 24$$

$$3! = 3*2*1 = 6$$

$$2! = 2*1 = 2$$

$$1! = 1$$

and now if we look closely  $4!$  is nothing but  $5!/5$  and  $3!$  is  $4!/4$ . Going on  $2! = 3!/3$  and  $1!=2!/2$  and leaping one step forward we can get  $0!$  that is  $1! /1$  and yes it results in 1. Isn't it baffling that multiplying no numbers together results in 1?

But this is how Maths is Beautiful.

Abhinav Pal  
B.Sc. Mathematical science  
Sem IV

# DENNIS PARNELL SULLIVAN ABEL PRIZE 2022 WINNER

## Introduction

Abel Prize is one of the prestigious award given in the field of mathematics for extraordinary work. It is given by the Norwegian Government and it is managed by The Norwegian Academy of Science and Letters. It is named after the great and brilliant mathematician Niels Henrik Abel. It comes with a monetary award of 7.5 million Norwegian kroner. This Award is also known as Nobel Prize of Mathematics.

## Detailed Information

Dennis Sullivan has won the 2022 Abel prize, for his wide-ranging contributions to topology, which is the study of how surfaces deform.

## SASTRA RAMANUJAN AWARD 2022

The award was instituted by the Shanmugha Arts, Science, Technology & Research Academy (SASTRA) in 2005. A cash prize of USD 10,000 is presented annually to individuals aged 32 and below, who made outstanding contributions in the field of mathematics, influenced by Srinivasa Ramanujan in a broad sense.

## Yunqing Tang- Ramanujan Award 2022 Winner

The SASTRA Ramanujan Prize for 2022 will be awarded to Yunqing Tang, Assistant Professor with the University of California, Berkeley, U.S.A.

Ms. Yunqing's works display a remarkable combination of sophisticated techniques, in which the arithmetic and geometry of modular curves and of Shimura varieties play a central role, and her results and methods are bound to have major impact on future research in this area.

Ankit Mudgal  
B.Sc.(H) Mathematics  
Sem IV

## MATHS TELLS US THREE OF THE SADDEST LOVE STORIES.

Tangent lines who had one chance to meet and then parted forever.

Parallel lines who were never meant to meet.

Asymptotes who can get closer and closer but will never be together.

Prince kumar  
B.Sc.(H) Mathematics  
Sem II

# TO READ AND SPEAK MATHEMATICS

To perceive and sense what you cannot actually touch, taste, smell, see, hear or feel in anyway has to be difficult.

“Mathematics is a language. Like all languages, with practice you get better at it. This process takes its own time. With patience you can get yourself one with this language of great tradition.”

You might have heard something of this sort before, you would have even experienced this to great extent or maybe, you will in the time to come, if you go on hard with your efforts. In layman’s language, the goal of language is to express a thought or an emotion to someone in a way that it is understandable, comprehensible and reproducible by the listener.

Let put our focus to a formal definition of language, “language, a system of conventional spoken, manual (signed), or written symbols by means of which human beings, as members of a social group and participants in its culture, express themselves. The functions of language include communications, the expression of identity, play, imaginative expression, and emotional release.

From this we can build our foundation firm enough to go forth learning mathematics. Mathematics, being as old as the written history, has great tradition, literature and many stalwarts.

To read this big stuff we must acquaint ourselves with the basis like algebra, set theory and more than anything, thinking in terms of mathematics, mathematical concepts, mathematical forms, mathematical mean and mathematical beings, unlike human beings, mathematical beings do not cheat. That is an assurance anyone can provide you.

The great literatures of mathematics which will be getting us to learn are all new, well actually not latest, fresh new but more like just 400-500 years new. That makes it a bit easier (pun intended and no offense).

The ways in which you can get yourself speak, read, and write mathematics is as simple and as hard doing the same in Hindi, Urdu, Punjabi, Bhojpuri, Awadhi, Telegu, Kannada, Malayalam, Tamil, English, German, French, Spanish, C++, Python, R, Java, JavaScript, TypeScript or even Elvish or any language.

Let us indulge ourselves in an example, an expression, say, sum of two squares to equal to zero, both are real numbers.

You may take the pain to write it in an equation form with symbols of English alphabets in Roman script but for our little time here I forsake that. The nature of those two numbers is our concern, for now. We have played far too well with numbers and their squares to say that they all turn out to be positive, if the number squared is not zero, in that case it would turn out to be zero.

These numbers are somewhere on real number line. As per the above statement they are squared so that makes both the numbers to be a positive number, now rather than being somewhere on the number line, for sure these numbers are not on the negative side of the number line.

With this cleared out, we see this sum of positives to be greater than zero. This goes against above mentioned statement, as it is said, the sum of squares is zero. That can only be possible where both the numbers are zero, only then the sum shall be zero.

This way you get to know the nature of the number and the number. If you can follow with each word and the thought expressed through these words and sentences you should have seen this reveal in front of your eyes. We can work this out in a formal manner by using the accepted notations of mathematics which saves us a lot of time which goes writing these words.

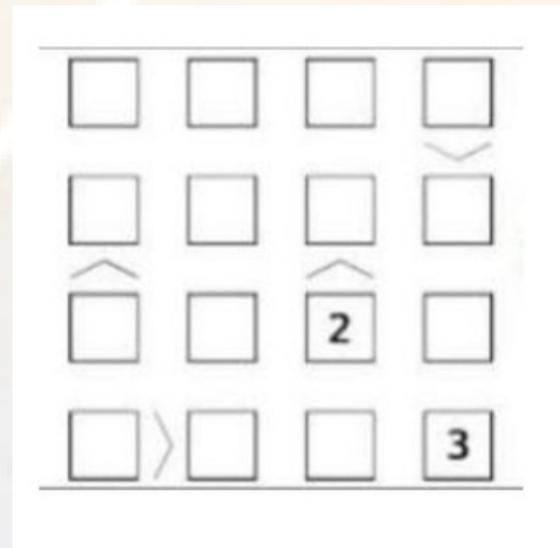
It is all about expression of thought in a format mostly accepted, easily reproducible and accessible, finding out an argument in the mathematical format is easier than spotting it in the pile of words.

Rishi Raj  
B.Sc. Mathematical Science  
Sem II

## Futoshiki

Rules of the game:

- Place the numbers 1 to 5( or higher if the puzzle is larger) into each row and column of the puzzle so that no number is repeated in a row and a column.
- All the number placed obeys inequality signs (<,>)



Answer in page number - 34

# SHAKUNTALA DEVI AS HUMAN COMPUTER

Shakuntala Devi, sometimes known as the "Human Computer," was an Indian writer and mental calculator who lived from 4 November 1929 to 21 April 2013. She earned a place in the 1982 edition of The Guinness Book of World Records. She didn't have any formal education.

SOME INTERESTING STORIES RELATED TO HER:-

1. In about 50 seconds, she provided the 23rd root of a 201-digit number in 1977 at Southern Methodist University. Calculations performed by the UNIVAC 1101 computer at the US Bureau of Standards, for which a special software had to be built to perform such a big computation and which took longer to complete than her own, corroborated her answer, which was 546,372,891.
2. She multiplied two 13-digit integers, 7,686,369,774,870 and 2,465,099,745,779, on June 18 of that year. The Department of Computing at Imperial College London chose these numbers at random. In 28 seconds, she accurately responded 18,947,668,177,995,426,462,773,730.

Abhinav Pal  
B.Sc. Mathematical Science  
Sem IV

## LIFE LESSONS WE CAN LEARN FROM MATHEMATICS

1. Mathematics gives us hope that every problem has a solution.
2. You have to be odd to be number 1.
3. Count on making a Difference!
4. Make your mistakes work for you by learning from them.
5. Success is the sum of small efforts.
6. The essence of mathematics is not to make simple things complicated, but to make complicated things simple.
7. Mathematics is a great motivator for all humans, because its career starts with zero (0) and it never ends( $\infty$ ).
8. Equation of success:-  
Faith + Hard Work + Consistency + Determination +  
Failure + Sacrifice + Learning = Success
9. Every problem has a solution; it may sometimes just need another perspective.
10. 1% better everyday can lead to big changes.

Gaurav Tiwari  
B.Sc.(H) Mathematics  
Sem II

# MATHEMATICAL APPLICATION IN CYBER SECURITY AND ETHICAL HACKING

In today's digital world, cybersecurity is more important than ever. With the increasing number of devices connected to the internet and the increasing use of online services, the risk of cyber attacks is also increasing. Cybersecurity is a complex field that requires a combination of technical skills and knowledge of various mathematical concepts. Mathematics plays a crucial role in ensuring the security of computer systems and protecting sensitive data from theft or unauthorized access.

One of the areas in which mathematics is used in cybersecurity is cryptography. Cryptography is the science of encoding and decoding messages so that they can be securely transmitted over the internet. Cryptographic algorithms use mathematical functions and number theory to encrypt data, making it unreadable to anyone who doesn't have the decryption key. Some common examples of cryptographic algorithms are RSA, AES, and SHA.

Another area in which mathematics is used in cybersecurity is ethical hacking. Ethical hacking is the practice of testing computer systems and networks to identify vulnerabilities and potential security threats. Ethical hackers use mathematical concepts and algorithms to analyze the security of a system and determine whether it is vulnerable to attack. Some common mathematical concepts used in ethical hacking include probability and statistics, graph theory, and linear algebra.

Mathematical algorithms are also used to detect and prevent cyber attacks. Machine learning algorithms, for example, can be trained to recognize patterns in network traffic and identify unusual or suspicious behavior that might indicate an attack. These algorithms use mathematical models to analyze large amounts of data and make predictions about the likelihood of a cyber attack.

Finally, mathematics is also used in developing new cybersecurity technologies. Researchers in the field are constantly exploring new mathematical algorithms and models that can be used to enhance the security of computer systems. For example, research in the area of quantum cryptography is exploring the use of quantum mechanics to create unbreakable encryption algorithms.

In conclusion, mathematics plays a critical role in ensuring the security of computer systems and protecting sensitive data from theft or unauthorized access. Whether it's through cryptography, ethical hacking, detecting and preventing cyber attacks, or developing new technologies, mathematics is an essential part of the field of cybersecurity. As the digital world continues to grow and evolve, the importance of mathematics in ensuring the security of computer systems and data will only increase.

Jayesh Gautam  
B.Sc. Mathematical Science  
Sem IV

# THE CULTURAL AND SOCIETAL IMPACT OF MATHEMATICS

Mathematics has had a profound impact on culture and society throughout history. In ancient civilizations, mathematics was used for practical purposes such as measuring land, keeping track of time, and performing financial transactions. As civilizations developed, mathematics became increasingly abstract and theoretical, and it came to be seen as a way to understand the underlying principles of the world around us.

In modern times, mathematics continues to play a vital role in society. It is used in a wide range of fields, including science, engineering, economics, and computer science, to solve problems and make predictions. Mathematics is also used in the arts and humanities to analyze and understand cultural and social phenomena.

One way that mathematics has had a cultural impact is through the creation of mathematical symbolism and notation, which has allowed mathematicians to communicate complex ideas and concepts to each other and to the wider world. Mathematical concepts and principles have also been depicted in art, literature, and other forms of creative expression, and have inspired the work of artists, writers, and musicians.

Overall, mathematics has had a profound influence on the way we understand and interact with the world, and it continues to shape our culture and society in countless ways.

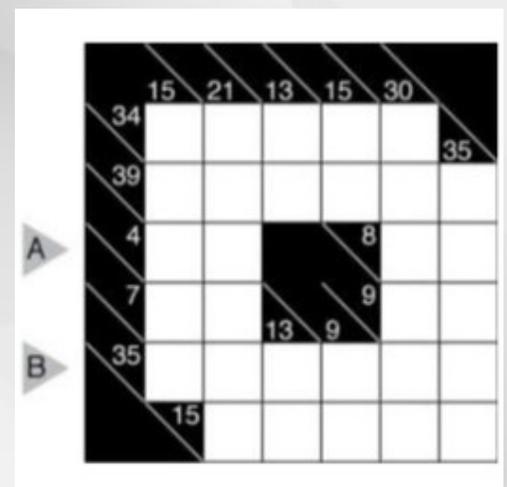
Harshit Bhatia

B.Sc.(H) Computer Science  
Sem IV

## Kakuro

Rules of the game:

- Fill all the empty squares using numbers 1 to 9 so that the sum of each horizontal block equals the clue on its left and the sum of each vertical block equals the clue on its top.
- No number may be used the same block more than once



Answer in page number - 34

# WHERE DOES THE BEAUTY OF A NUMBER LIE, CAN'T BE BETTER EXPLAINED THAN THE "PI"

- It goes on and on without any repetition, human mind cannot decode this magical sensation.
- Ratio of a circle's circumference to its diameter, definition is easy, computation is a brain-eater.
- "Albert Einstein" of the numbers we can say, even the greatest physicist was born on "Pi day".
- The number Pi has played a role in every life on earth, from physics to mathematics it has always proved its worth.
- Humble Pi is constant- It is inspirational, oh wait I forgot, it is highly "Irrational".

Prince kumar  
B.Sc.(H) Mathematics  
Sem II

## EQUATION OF LIFE THROUGH MATHEMATICS

Life + Love = Happy

Life - Love = Sad

---

$2\text{Life} = \text{Happy} + \text{Sad}$

$\text{Life} = \text{Happy}/2 + \text{Sad}/2$

Therefore,  $\text{Life} = 1/2 \text{ happy} + 1/2 \text{ Sad}$

Mathematics is Fun when you - defeat ,  
Fear learn to Understand and play with  
Numbers.

Sneha ahuja  
B.Sc.(H) Mathematics  
Sem II

# ARYABHATTA AND HIS INVENTIONS

“Aryabhata invented 0; He valued nothing, thus he valued everything”

About Aryabhata

Birth- 476 CE Birth

Place- Kusumapura, capital Pataliputra in the Gupta Era. Present Day- birthplace is known to be Bihar, Patna, India.

Works- His Most Notable work is Aryabhatiya and Arya Siddhanta.

Death- 550 CE

His Inventions and Discoveries

Aryabhatia :- This book is also called Arya-status-ash which is directly translated as Aryabhata's 108 because in the text there are 108 verses. It is written in the form of a sutra that is a collection of aphorisms which is a concise way of writing a statement or a scientific principle.

Mathematical Discoveries:-In Aryabhatiya Indian Mathematical Literature was extensively mentioned. The Vedic way to solve mathematical problems was explored and unsurprisingly this has also survived to modern times. The details of algebra, arithmetic, plane trigonometry, spherical trigonometry were discussed. He followed the Sanskrit tradition or method of calculations that were prevalent in the Vedic Times. The title of 'Father Of Algebra' was given to Aryabhata, due to his notable understanding and explanation of planetary systems using it. Aryabhata correctly concluded the value of pi up to 2 decimal places, 3.14.

He also used null coefficients and very rightly was aware of the use of zero in such a place. He used Sanskrit tradition that was mainly denoted by letters and alphabets, unlike the Brahmi numerals.

Thus, He Gives the world “Zero”

Sajal Agrawal  
B.Sc. Physical science  
Sem II

# POEM



## Mathematical operation in life

Count your blessings, God-given; Add  
them one by one, each day; Subtract your  
pessimism;

Divide time for all your works; Multiply  
your joys in life;

Get success in earthly stay,  
By praying to the Lord.

Numbers are infinitesimal;  
Numbers are so magical;  
Numbers can have decimal;

Numbers rule the modern world.  
Numbers are abstract / real; Numbers can  
amuse us all;

Numbers are the 'bricks' of Maths!  
Numberless, world is dismal.

They can count your hair, these days; They  
can count the stars, some ways; Man's  
progression in Maths is base, For putting  
man on Moon, or Mars?

Numbers make computers work;  
Hypotheses form the science;

Integers are wonders too; A genius in  
mathematics Is a MATHEMAGICIAN!

Sajal Agrawal  
B.Sc. Physical science  
Sem II



## Maths Biggest Hero Is Zero

Everyone to blame and no one to pat  
But I am a zero, and I am proud to say that

To Those whom I mean nothing  
Do they really know about me anything?

When I ride with 1, I take ten to infinity  
See, I am born with this big ability

Neither positive nor negative, I am zero  
My dear friends call me Hero

Unlike other members, I hold my place  
Hence no one can take my space

No perfect hundred exist without me  
So other members also want me to stick like a bee

You move your hand round and round  
And you will see me all around

There may be endless numbers greater than me  
But can they defeat the magic of me?

After all this, I am never in limelight  
And still people question my might

And story remains the same,  
Everyone to blame and no one to pat  
But I am a zero, and I am proud to say that!

Sanya Jain  
B.Sc. Mathematical science  
Sem IV



## Mathematics : A language

Mathematics, a language so grand,  
A world of numbers at our command.  
With equations, we can solve and prove,  
The mysteries of the universe we move.

From the simple sum of two and two,  
To the complexities of calculus, it's true.  
With each formula and every proof,  
We gain understanding, wisdom, and truth.

In this realm of logic and design,  
There's beauty in every equation, line by line.  
Symbols and numbers dance on the page,  
Expressing patterns, symmetry, and age.

Oh, mathematics, how you inspire,  
With your theories that never expire.  
You guide us in our quest for knowledge,  
And help us build a bridge to the college.

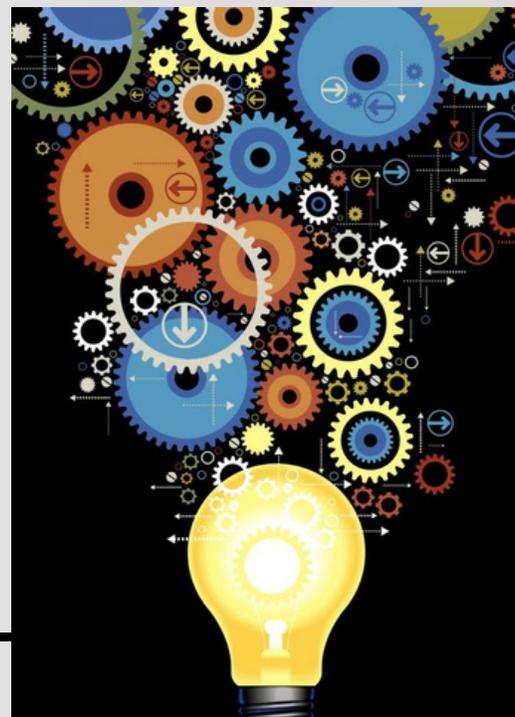
So let us celebrate this language so wise,  
And bask in the glory of its bright, shining eyes.  
For mathematics is more than just numbers and form,  
It's the foundation of the universe, a true work of art.

Shagun Gupta  
B.Sc.(H) Mathematics  
Sem VI

## Polychromatic Skies

The Millenium Prize Problems should consist of eight  
The newest addition, as it finally dawns on me, is  
As I recall my hopeless pokes at problem sets  
Started from the fear of the grade "F"  
End, incomplete  
Albeit  
Triggering the narrowest beam of sunshine seen  
Making the thousands of unfulfilled specks visible  
Again  
All I wished were hyperbolic journeys  
Laughter at sinusoidal frequencies  
Polychromatic skies  
And you, by my side  
But  
But  
Isn't it fascinating that it takes less than a millimetre  
To reach the conclusion  
Math says one slit is smaller than a lifetime  
Funny  
I kept searching for an answer in your eyes for too long  
That the soul abandoned without a goodbye  
Now, as I look out for theorems  
To prove that I'm still alive  
The practice from the hopeless pokes  
Seems to come in handy

Manish Leekha  
B.Sc.(H) Mathematics  
Sem VI



# How Do I Cruise?

We all have learned to navigate life through a mixture of methods, some from our mother's teachings and some from the most dreaded math classes. I have learned most of the things by trial-and-error method.

The one that my mathematics teacher always said is the most crude and inefficient way to solve any problem, and always discouraged us to use it.

But I can't go without hopscotching between every option till I end up in chaos. I can't dare to preassume and let X be the solution of my hysterical equation and then go around stumbling and trying to fit it in.

I find solace in the world of numbers and statistics, where I keep a record of every minute tone change in most unimportant conversations, counting the number of eye contact breaks and awkward pauses in between, and plot a graph of this pivotal data before starting my day.

With each plotted point and graph extrapolated,

I foresee where a situation is supposed to go or analyze and predict people's moods for the day.

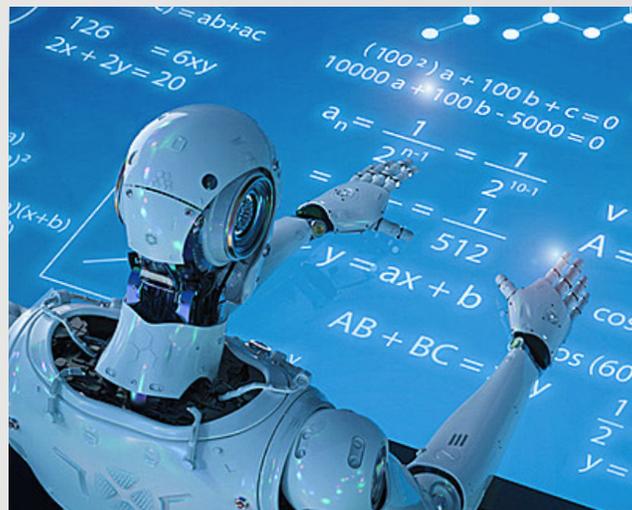
With each new insight I gain, I must also face my own flaws.

The fear of speaking up, of revealing my true self, and the possibility of failing, hold me back.

So, I visit back those thick yellow paged books to find some new formulas and equations.

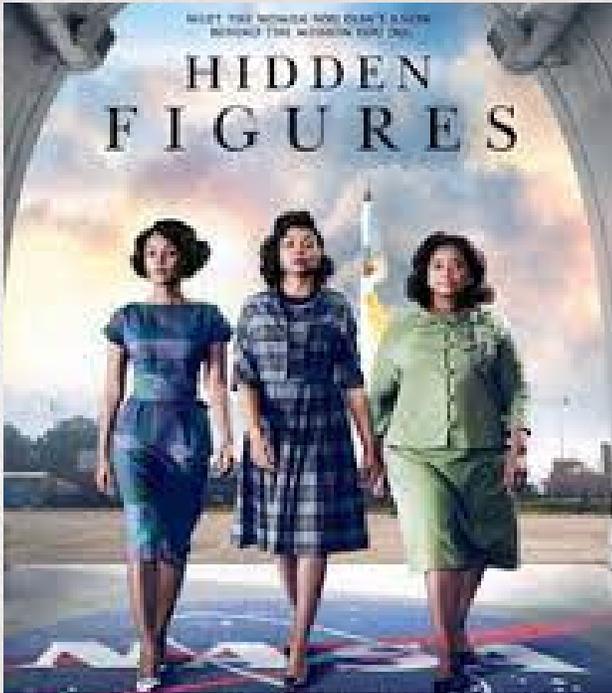
Chetan Yadav

B.Sc.(H) Computer Science  
Sem IV



# Movies

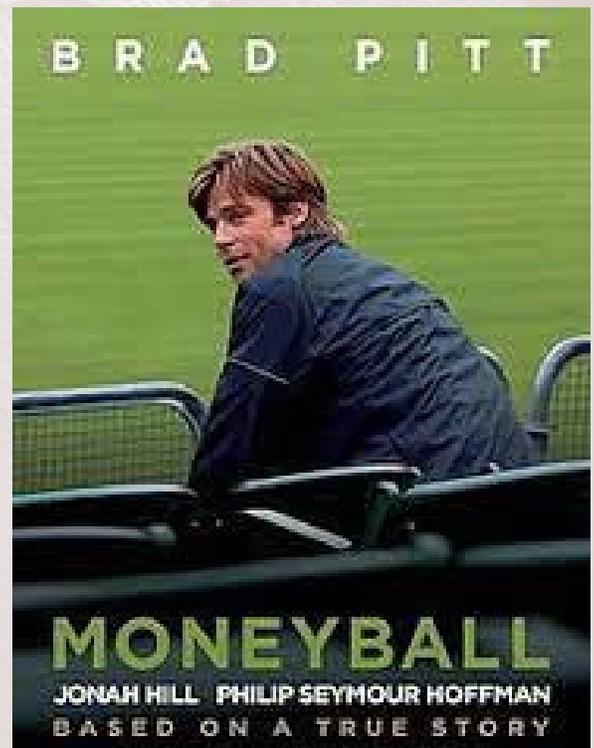
## 1. Hidden figures



Hidden Figures is a 2016 American biographical drama film. It is loosely based on the 2016 non-fiction book of the same name by Margot Lee Shetterly about three female African American mathematicians who worked at NASA during the Space Race. They play a pivotal role in astronaut John Glenn's launch into orbit. Meanwhile, they also have to deal with racial and gender discrimination at work. The film was chosen by the National Board of Review as one of the top ten films of 2016 and received various awards and nominations, including three nominations at the 89th Academy Awards, including Best Picture.

## 2. Moneyball

Moneyball is a 2011 American sports drama film. The film is based on the 2003 nonfiction book by Michael Lewis, an account of the Oakland Athletics baseball team's 2002 season and their general manager Billy Beane's attempts to assemble a competitive team. In the film, Beane and assistant general manager, faced with the franchise's limited budget for players, build a team of undervalued talent by taking a sophisticated sabermetric approach to scouting and analyzing players.



### 3. Shakuntala Devi

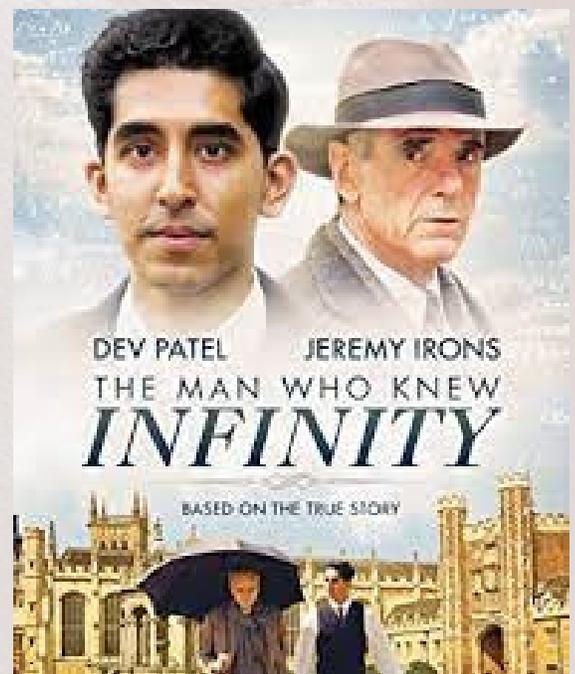


Bestowed the title 'Human Computer', Shakuntala Devi was given a place in the Guinness World Records as the fastest human to compute two randomly selected 13-digit numbers in 28 seconds, 40 years ago! To know more about this great mathematician and to believe about what truly happened in her life, a great movie have been featured in the bollywood cinema by the name Shakuntala Devi

The movie depicts colourful life of her and has so much that could inspire even today's generation.

### 4. The man who knew infinity

Srinivasa Ramanujan was a brilliant mathematician who grew up poor in India but eventually attended Cambridge and contributed heavily to the field of mathematics in his brief life. Even though he died in 1920 at age 32, his research continued to be confirmed, and it still inspires new areas of research to this day. Ramanujan's story was recounted in the 1991 biography "The Man Who Knew Infinity," which was later adapted into a 2015 film starring Dev Patel as Srinivasa alongside Jeremy Irons, Devika Bhise, Toby Jones and Stephen Fry.



# Answers

Answer of Page number-9

+ - X ÷				
1- 3	2+ 1	2 2	20x 4	5
2	14+ 4	3	5	1
20x 4	5	12+ 1	2	36x 3
1	2	5	3	4
15x 5	3	4	1-	2

Answer of Page number- 23

Answer:

1	2	3	4
3	4	1	2
4	3	2	1
2	1	4	3

Answer of Page number-26

	15	21	13	15	30		
34	4	6	7	8	9	35	
39	5	4	6	7	8	9	
A	4	1	3		8	1	7
7	2	5		9		3	6
B	35	3	2	9	6	7	8
	15	1	4	3	2	5	

# STUDENTS WHO MADE US PROUD



**Anurag Juneja**

Secured AIR-28 in JAM MA



**Mishiti Chauhan**

Cleared AFCAT 2 2022 and  
UPSC-CDS 2 2022



**Shagun Gupta**

Secured AIR-410 in IIT JAM



**Dhiraj**

Cleared Afcats 1 2023



**Plakshi Gupta**

Secured AIR-1734 in IIT JAM



**Bhavay Luthra**

Secured AIR-1416 in IIT JAM

# ALUMNUS



**Mohammad Sadiq Ansari**

Gold Medalist AIR 9 DUET , Master of Operational Research



**Aman Batra**

Secured AIR 13 in DUET Master of Operational Research



**Aishwarya Raman**

Studying M.Sc. Maths in University of Glasgow, Scotland, UK | Secured 3rd rank in Physical sciences course 19-22



**Tushar Sharma**

Cleared AFCAT for the post of flying officer

# ***FUTURE PROSPECTS***

- **IT Industry:**

The Information and Technology Industry is the best option to utilise your Mathematics Degree if computer algorithm is your field of excitement.

- **Accountancy & Management:**

The knowledge of accountance,finance gathered during graduation in mathematics degree helps one furnish their Management skills. If you are someone with business fever then it is most advicable for you.

- **Actuarial Sciences:**

It is a stream with bright future for you if you are interested in probability and statistics. Mathematical Modeling is a must for acturians for calculating the financial impact and appraisal of the organization.

- **Investment Banking**

The career in Investment Banking is magnificent and fastpaced. Mainly it helps to offer financial advice and services to government and private large industries and individuals with large scale capital,thus helping in utilisation of mathematics degree.

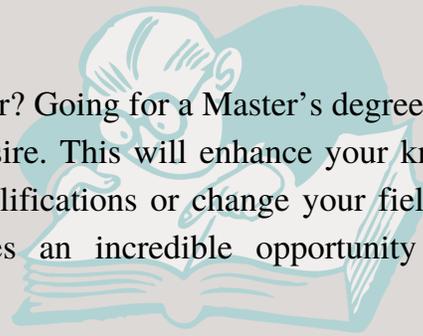
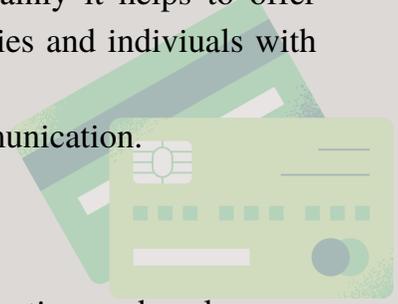
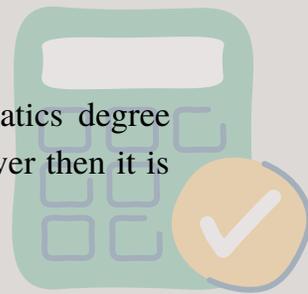
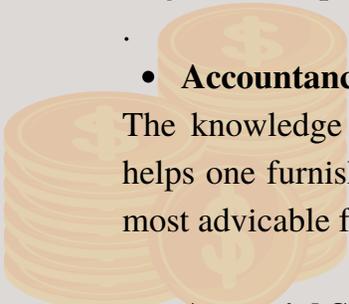
It offers a large number of jobs in retail banking and in customer communication.

- **Operational Research Analyst:**

Operational Research Analysts improve the strategies of an organization and makes one apply their mathematics skills to improve efficiency and solve real life problems.

- **Teaching:**

Aspire to be a Teacher? Going for a Master's degree program and acquiring a Ph.D. will help you to fulfil your desire. This will enhance your knowledge in a particular field. You may gain professional qualifications or change your field of study as well. Achieving a PhD in mathematics proposes an incredible opportunity to make an original contribution to mathematics.



- **Mathematician**

As the profession itself suggests, it involves research work and reviewing data using mathematical and statistical techniques in every field, may it be healthcare or engineering

- **Government Jobs**

People find a suitable job in government institutions and other sectors. There are some added incentives and benefits attached to it. Most of these jobs need reasoning. These aspirants seem to have an upper hand over such jobs. Some competitive exams come with these jobs which one has to crack. Therefore a graduate can easily hit the bull's eye.

Jobs offered in various public sectors and institutes like ISRO and DRDO.

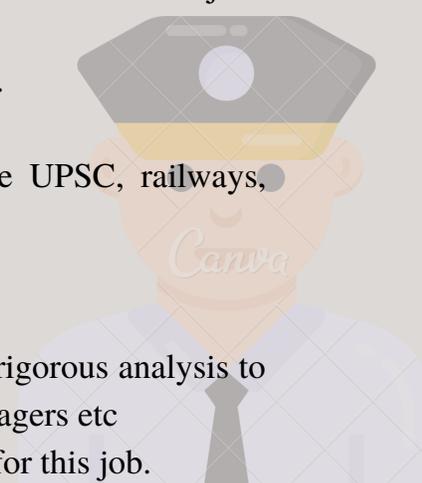
After BSc mathematics, it is one of the most attractive careers .

An aspirant can also go for some competitive government exams like UPSC, railways, banking, etc. and can easily get into various government departments.

- **Financial Analyst**

It is a brilliant way to apply one's mathematical knowledge by involving rigorous analysis to help traders which includes investment management companies, fund managers etc

It is a well reputed job sector thus maximum number of candidates apply for this job.



**DID YOU KNOW?**

From 0 to 1000, the letter 'A' appears only once in 1000.  
(One Thousand).

# DEPARTMENT OF MATHEMATICS:

## FACULTY



Top (L-R): Dr. Janson Antony, Mr. Deepak Kumar Meena, Mr. Ankit Kumar, Dr. Ram Chander Verma, Dr. Panjabi Singh and Dr. Ravi Kumar  
Bottom (L-R): Dr. Ashish Bansal, Dr. Richie Aggarwal, Dr. Arpana Sharma, Dr. Rajni Mendiratta, Ms. Rajat Arora and Dr. Dhanpal Singh

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(L-R) : Ishika Minocha(B.Sc. Mathematical science, Sem VI), Shagun Gupta(B.Sc.(H) Mathematics, Sem VI), Dhruv Goyal(B.Sc.(H) Mathematics, Sem IV), Aastha Bhagat(B.Sc.(H) Mathematics, Sem IV), Anmol Madan(B.Sc.(H) Mathematics, Sem IV)



**B.SC. (H) MATHEMATICS**



**B.SC. MATHEMATICAL SCIENCES**



**B.SC. PHYSICAL SCIENCE**

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