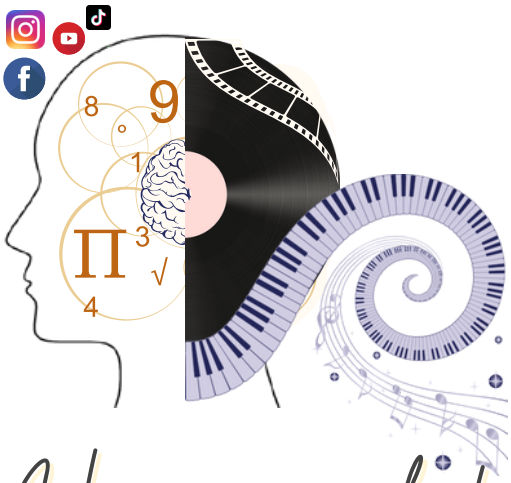


ALGORITHM

NEWSLETTER - DEPARTMENT OF MATHEMATICS, JMC

Harmony between math , music and poetry

If you've truly ever enjoyed mathematics, been moved by music, and felt poetry in your bones, this article is perhaps no surprise for you. You've felt the connection between the three, but what about the logic behind it?
If we look at the definition of these three, a common piece that links them is a kind of arrangement. In a poem, words are arranged carefully for their beauty and sounds, in music, sounds are arranged through melody and rhythm, and mathematics is a field of study that deals with the logic of quantity and arrangement. As we know that between three quantities, transitivity is best used to establish a relation. We shall make use of this very concept to establish the connection between these three forms of art (and yes, math is art).

The connection between poetry and music is innate. Despite being two independent forms of art, they draw inspiration from each other, especially in terms of rhythmic patterns. Both performed arts, music and poetry have a deep effect on humans and represent culture and history. Poetry can be sung without music (reading), and music without words is poetry (such as an instrumental performance)! Hence, music is poetry and poetry is music.

Now that we have established a connection between poetry and music, let's move on to understanding how mathematics is connected to both.

What's Inside!

The relationship between mathematics and poetry, while less obvious, is equally compelling. Although poetry is often considered an abstract art form, there is a strong mathematical component to its structure. A line in a poem can have multiple meanings as layering is quite common in this art form.

But there's more – Poems often use a mathematical approach in their structure. A 14-line sonnet, for example, is written in three sets, and each set has 4 lines. In addition, there is another set with two lines. There has to be a pattern of stressed and unstressed syllables in each line. The mathematical structure helps deepen the impact of the written work. Similarly, a Haiku has only 17 syllables – 5 in the first line, 7 in the second, and 5 in the last.

A 6-line poem that follows the Fibonacci pattern for syllable count per line is also known as Fibonacci poetry, which was created by Gregory K. Pincus.

Fibonacci style is a non-rhyming style that uses the numbers 1, 1, 2, 3, 5, 8, 13, 21, and 34 in the syllable count.

Poetry can also be found in mathematics. Theorems, proofs and principles can be stated in poetic ways. The Pigeonhole Principle, for example, can be stated as follows – 'if the number of pigeons residing in your pigeon house is more than the number of pigeonholes, then at least one pigeonhole must have more than one pigeon'.Using poetic language to describe mathematical concepts, we can create a deeper understanding of these abstract ideas.

Hence, from counting the number of lines, determining the appropriate number of syllables, and developing the appropriate word pattern, almost every part of poetry incorporates maths.

Although it may not be immediately obvious, there is a close relationship between the field of mathematics and the art of music, and maths is woven into the very fabric of music.

With Pythagoras' exploration of the tones generated by string-pulling on various-length instruments, a new field of study emerged that would eventually be known as music theory. The fundamental harmonic system that is still in use today is formed by the intervals, or spaces between notes, that Pythagoras discovered via meticulous observation.

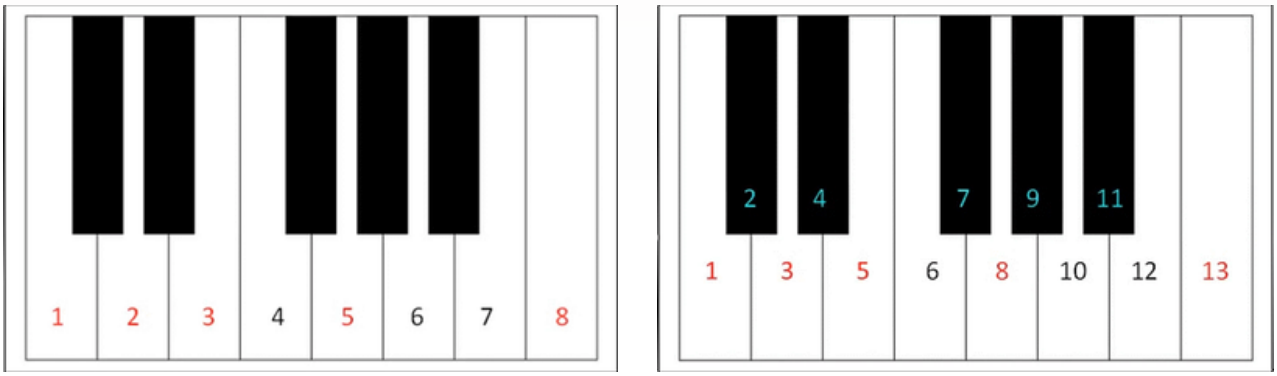
The mathematical idea of the "golden ratio" inspired outstanding musical compositions by artists such as Mozart.

By applying mathematical methods to blend pitch and timber on a computer in 1980, Jonathan Harvey contributed to the emergence of electronic music & electronic composing.

Moreover, the music set theory can easily be related to the set theory we study in mathematics. Here, musical instruments and objects are organized and their relationships with each other are well defined. Abstract Algebra is also used in the analysis of music.

In addition, logarithms are used in music to represent intervals or tones. Logarithms are used to express decibel sounds and are related to both intervals and tones. Additionally, logarithms are utilized to inform the musician of the composer's intentions.

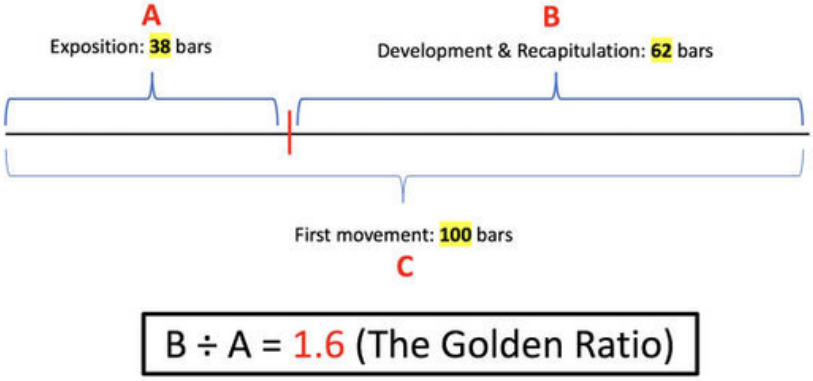
The concept of the "golden ratio," which refers to a particular number roughly equal to 1.618 (symbol is the Greek letter "phi"). It is present at the keyboard of a musical instrument. It is found on the piano keyboard: the C to C scale comprises a total of 13 keys, 8 of which are white and 5 of which are black, divided into groups of 3 and 2. The 5th note of the major scale, which is also the 8th note of the 13 notes that make up the octave, is the dominant note in a scale. It's interesting to note that 8/13 is .61538, which is close to phi.



Outstanding musical creations have even been influenced by the Golden Ratio, including several of Mozart's piano sonatas. There are two parts of a sonata: the musical subject is introduced in the exposition of a sonata, and it is developed and repeated in the development and recapitulation sections.

In the diagram above, C represents the entire first movement of the sonata, B represents the development and recapitulation, and A represents the exposition.

38 bars make up the exposition, and 62 bars make up the development and recapitulation. There are 100 bars in the entire first movement. The ratio of 62 to 38 is 1.63. (approximately the Golden Ratio)
Thus, Mozart arranged his piano sonatas so that the ratio of the bars in the development and recapitulation to the bars in the exposition is equal to the golden ratio.

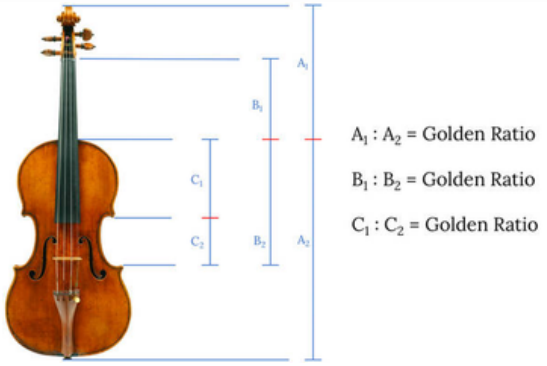


How musical instruments are made is another way in which the Golden ratio relates to music. Some of the most stunning and powerful violins ever produced were by Antonio Stradivari. Some people believe that one of the reasons his violins were so excellent is that the Golden Ratio could be found by dividing the lengths of specific violin sections.

Hence, like the golden ratio, other concepts also find their way into the music industry.

Martin Bergee, a professor and researcher at a university in Kansas, thought there was no connection between mathematics and music. He conducted a study on 1000 middle school-aged students' test scores with undeniable conviction, yet he was proved wrong. In fact, he discovered much more solid proof of the link between musical ability and success in maths and reading.
He said: "The explanation for the association is that learning is an incredibly interconnected phenomena that is difficult to isolate and is not modular. If you remove music from the classroom, everything suffers".
Therefore, we can conclude that maths and music are related; maths contributes to music, and music equally aids in comprehending mathematics.

Mathematics can sometimes seem abstract and remote from everyday life. But as you can see from our discussion about its relationship to music & poetry,the three bring life and soul to one another and help us connect with ourselves and the world in different ways.
Mathematics is a subject that actually plays an 'integral role' in our daily experience.



CONTENT BY: ATIPRIYA DEV SINHA

from the

EDITOR'S DESK

Editor-in-chief

Dear Readers,

Are you ready to embark on a thrilling journey exploring the intricate connections between maths, music, and media?From the algorithms that make our favourite movies work to the rhythms and melodies that move us in music, maths is the unseen force behind it all. This 8th edition of our newsletter will have you grooving to the beat of algebra and rhyming to the rhythm of calculus!

Our first article takes a closer look at the similarities between maths and poetry, discussing how these disciplines share a common language and structure.We'll also delve into ways in which mathematical concepts can be transformed into lyrical masterpieces.
Algebra and music may seem like an unlikely pair, but they are actually intertwined in more ways than you might think.In our article we explore how geometric inversion, a transformation using reflections in a circle or sphere, can be used to create scales based on harmonics and intricate musical patterns.
From calculating the movements of characters and objects to creating realistic lighting and textures, maths is an essential tool that animators use to bring their stories to life.This article will surely capture your imagination and show you a new mathematical side of the animated worlds you know and love.

Whether you're a maths whiz, a music lover, a wordsmith, or just curious about the hidden connections between these subjects, we invite you to open your mind as we explore the interconnectedness of maths, music, and media.

Happy Reading!

MATHS OF MUSICAL SCALES

Pythagoras, the father of music theory, famously said, "There is geometry in the humming of the strings, there is music in the spacing of the spheres." This statement highlights the connection between mathematics and music, which has been explored for centuries. One of the fundamental concepts in music theory is the scale, which is a set of musical notes arranged in ascending or descending order of pitch. The major scale, for example, consists of seven notes and an octave note

Definitions to understand the article:

Pitch - Perceptual property of sounds that enable their ordering on a frequency related scale which allows their further classification as higher and lower pitch when associated with musical melodies.

Octaves - Interval or distance between two pitches where one has a frequency twice the other.

Frequency - Number of cycles per second of a sound wave**.**

Tuning- This refers to the adjustment of a sound source, such as a voice or a stringed instrument, to produce a desired pitch in relation to a given pitch.

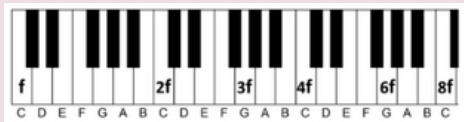
Pythagoras discovered the link between pitch and frequency and established the foundation of music theory based on mathematics. He recognized that when the ratio of two notes is a simple fraction, they sounded melodious. For example, ratios 2:1, 5:3, 3:2, and 4:3 are commonly known as an octave, major sixth, perfect fifth, and perfect fourth, respectively. Legend has it that Pythagoras saw a blacksmith hammering metal beams which produced different sounds as the length of the beam differed. This led him to invent a monochord, using which he came to the conclusion that plucking a string at different lengths produced different sounds. He discovered that plucking a string at two-thirds and three-fourths lengths produced pleasing sounds.

Let us dig a little deeper

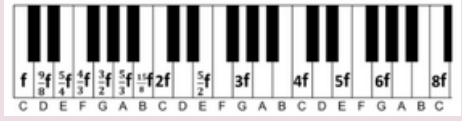
The current music system (western music system) consists of 12 notes namely C,
D, E, F, G, A in addition to 5 flats and equivalent sharps in between. Let A0 be the frequency of the first note in any given scale. There must be a fixed ratio increase or growth by a fixed percentage, say r, every time you advance by a half-step to the next note (percentage written as a decimal). So the frequency is on the second note. Therefore, the second note will have the frequency A1=A0(1+r). Similarly, for the third note the frequency will be A2=A0 (1+r)(1+r) =A0(1+r)2. So after the 12th note therefore this will be equivalent to A12=A0 (1+r) ^12= 2A0, this happens because once we have covered 12 notes, we have covered an octave and as discussed above, the ratio is 2:1 for an octave. Solving the above equations will provide us with the value r =1.059.

Since we have already covered in the definition of an octave that while considering two pitches one will have twice the frequency of the other. So suppose the first C has a frequency ‘f’, then the subsequent C’s will have a frequency of 2f, 4f and 8f respectively.

Observing the above ratios will give us the positions 3/2f, 3f, and 6f will be the frequency of the first, second and third G respectively.



Now we can establish the fact that 5f will be the frequency, as we descend the frequency of the second E will be 5/2 f and the first E would be 5/4 f. Similarly, calculating all other frequencies will give us:



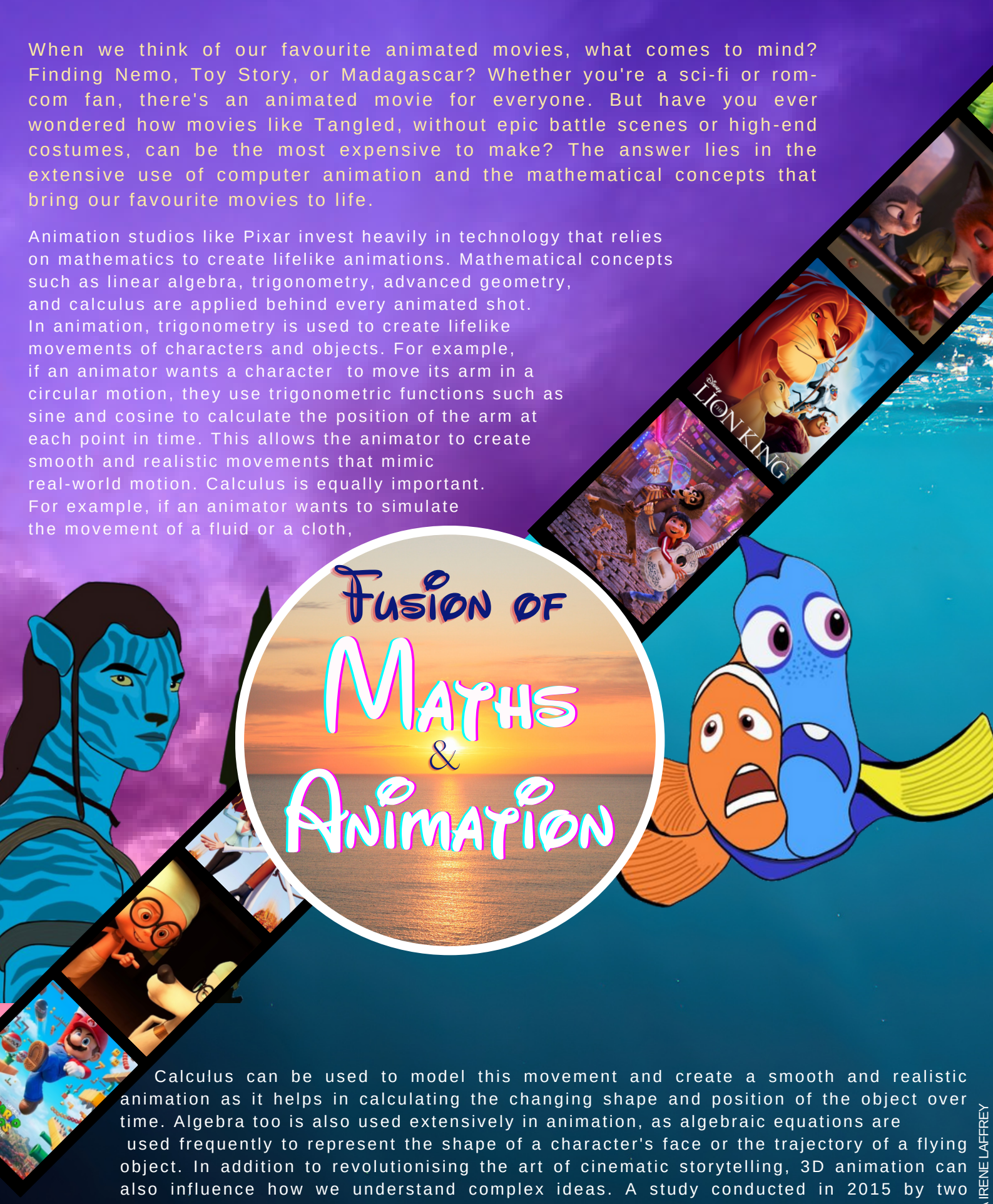
So, now a question might arise regarding the use of the above-mentioned calculations and formulae. Well, in order to check whether two notes played at the same time will be soothing to the ears or not, the calculation of ratios might be of huge help. Divide the fractions and reduce it to the most basic form possible, and if the denominator is a huge value, certainly, it would be unpleasant to hear. This fascinating link between music and mathematics provides a deeper understanding of the principles of sound and harmony, and how they can be manipulated to create beautiful melodies.

CONTENT BY: AAN MARIA JAMES

Fusion of Maths & Animation

When we think of our favourite animated movies, what comes to mind? Finding Nemo, Toy Story, or Madagascar? Whether you're a sci-fi or rom-com fan, there's an animated movie for everyone. But have you ever wondered how movies like Tangled, without epic battle scenes or high-end costumes, can be the most expensive to make? The answer lies in the extensive use of computer animation and the mathematical concepts that bring our favourite movies to life.

Animation studios like Pixar invest heavily in technology that relies on mathematics to create lifelike animations. Mathematical concepts such as linear algebra, trigonometry, advanced geometry, and calculus are applied behind every animated shot.
In animation, trigonometry is used to create lifelike movements of characters and objects. For example, if an animator wants a character to move its arm in a circular motion, they use trigonometric functions such as sine and cosine to calculate the position of the arm at each point in time. This allows the animator to create smooth and realistic movements that mimic real-world motion. Calculus is equally important. For example, if an animator wants to simulate the movement of a fluid or a cloth,



Calculus can be used to model this movement and create a smooth and realistic animation as it helps in calculating the changing shape and position of the object over time. Algebra too is also used extensively in animation, as algebraic equations are used frequently to represent the shape of a character's face or the trajectory of a flying object. In addition to revolutionising the art of cinematic storytelling, 3D animation can also influence how we understand complex ideas. A study conducted in 2015 by two professors at National Chiayi University, Taiwan, examined the effect of computer animation on students' comprehension of mathematical concepts. The study developed 3D animation on binomial theorems, and the results from questionnaires showed that animation significantly improved students' ability to comprehend various mathematical concepts.
Mathematics and animation impact each other, making learning easier and the beauty of stories portrayed through movies even more enjoyable.

CONTENT BY: ANGELINA IRENE LAFFREY


MADAGASCAR


MADAGASCAR


MADAGASCAR

MUSICAL ABILITIES

MATHEMATICAL CAPABILITIES

After spending hours grinding onto these mind boggling mathematical problems, we all deserve a break and what better way of doing this than listening to some of our favorite music. Does it not help you recharge immediately?

When music enters our brains, a neurotransmitter, known as Dopamine is released, triggering our pleasure center, which is responsible for making us happy.
Our brains function better when we listen to music, and it also helps us become better readers and problem solvers. Researchers have reexamined the connections between musical experiences, music learning, and academic accomplishment in light of Gardner's idea of multiple intelligences. According to studies, the connections between music and mathematics—more specifically, between music and performance in reading and music and spatial-temporal thinking, which is crucial for understanding mathematical concepts—are the most significant. Furthermore, specific forms of musical practices have been linked to human cognitive growth in neuroscientific study.

The development of spatial-temporal skills are considered to be strong predictors of achievement in mathematics.
In 1993, Shaw and Rauscher provided some intriguing information about the connection between listening to music and performing dimensional tasks. Certain frequencies of sound stimulate each hemisphere of the brain differently. Listening to music can possibly create more balance between the two sides and improve cognitive skills.
In 2004, Schellenberg examined changes on an IQ test and a standardized test of academic achievement after a programme of musical activities. The findings showed a small increase in IQ in those groups who did keyboard or voice training compared to drama or control groups.
Some research even shows that children who indulge in playing musical instruments are more creative, have better memory, attention span and improved motor skills.
In 2012, one study showed that listening to music during a math test could improve performance by 40%. In 2017, Sylwia Holmes and Susan Hallam conducted a study to understand the music-math relationship.

The study had a quasi-experimental setup in which children aged 4 -7 years participated in a music program containing mainly rhythmical music activities. Parallel classes are made up of control groups. The results of the experiment supported the hypothesis that music has a great impact on the development of Spatial-temporal skills.
However, achievement in general mathematics didn't differ between the intervention(experiment) and control groups, but it showed statistically significant enhancement in learning mathematics amongst the youngest participants of the programme. Indicating that the earlier you become close to music, the better!
The connection between active engagement in music and learning mathematics is more subtle than a general impact on academic achievement.
All we can say is that next time you are stuck on a problem try listening to some music, at the least, it'll help calm your nerves and who knows, probably you'll even solve it!

CONTENT BY: REEYA JOSHI

ARTISTIC FLARE OF MATHEMATICIANS

Do you know that there have been mathematicians who have written poetry and music? If not, this article will introduce you to a few musically inclined mathematicians.

Donald Ervin Knuth

Did you know that Donald Ervin Knuth, the man who is known as the father of "analysis of algorithms," is both a composer and an organist? Isn't it amazing that an American mathematician and computer scientist who is renowned for his contributions to the study of algorithms and for creating the TeX typesetting language also appreciates music.

His father inspired his fascination with music. From playing a church organ during Sundays, playing saxophone and tuba in the school band to joining the American Guild of Organists in 1965,he had nearly given his entire life to his tremendous love of music.

Sarah Glaz

Women are also well represented among musically talented mathematicians. Born in 1947, Sarah Glaz is a mathematician and a mathematical poet. She is an emeritus professor of mathematics at the University of Connecticut with a focus on commutative algebra.

Ode to Numbers, a collection of her mathematical poetry named after a poem by Pablo Neruda, was published in 2017. She is also the co-editor of Strange Attractors: Poems of Love and Mathematics , an anthology of mathematical poetry, and has published translations of poems into several languages .

Thomas Andrew Lehrer

Thomas Andrew Lehrer, too, was an American singer, songwriter, artist and mathematician. He started writing songs at the young age of 14.One of his most beloved compositions, "The Elements," sets the names of every chemical element known at the time to the tune of "Major-Song" General's from the comic opera The Pirates of Penzance by W. S. Gilbert and Arthur Sullivan.

Known to be a genius throughout his academic career, he taught both musical comedy as well as mathematics. Nonetheless, Lehrer's job as a math teacher did not deter him from performing his music; according to a 1998 article in the British magazine The Spectator, Lehrer had made "109 concert appearances," throughout his career.

In 1953, he released his debut album, "Songs by Tom Lehrer," on his own record company, Lehrer Records.

CONTENT BY: REEYA JOSHI

THE MELODY OF ALGEBRA

"There is geometry in the humming of the strings, there is music in the spacing of the spheres. ~Pythagoras". Mathematics and Music may appear to be sharply contrasting fields, but for many centuries they have been strongly intertwined. Let us delve a little deeper into this article that deals with geometric transformations such as inversions. It also highlights group theory and its application in music. Music theory also includes the concept of inversions for composing music. These inversions can be given a structure which then leads to the definition of a group, subgroup and a coset. Interestingly, we must note that many musical notes can be expressed in numbers.

Some basic knowledge about piano:

Let us look at the basics of Piano required for the further development.-?

All these keys of the piano are called key positions. The interval between any two adjacent keys whether black or white- is called a half step.

- The pitch that is one half step above the primary pitch is called sharp, Sharp is denoted by #.
- The pitch that is one half step below the primary pitch is called flat. Flat is denoted by b.

and b are called accidentals. If D is the primary pitch then D# is called D-sharp and Db is called D-flat.

The basic principle of the keyboard and harmonium is that any other key which is 12 steps above produces a pitch whose frequency is exactly double that of the lower key.

To the ear, these two sounds seem related and they are being defined as one OCTAVE apart. For example, the key in position 15 is one octave higher than that in position 3, and the key in position 31 is two octaves higher than that in position 7. We must observe that there is a difference of 12 in 3 and 15, there is a difference of 24 in 7 and 31. Hence, the position y is k octaves higher than position c if y=x+12k for k = 1,2,3…… In number theory, it is said y is congruent to modulo 12. The pitch class containing x is the set of all integers congruent to x modulo 12 and is denoted by [x]12.

Names taught in music theory that traditionally designate pitch classes according to our numbering scheme are:

$$C = [0]_{12} \qquad C\# = Db = [1]_{12}$$
$$D = [2]_{12} \qquad D\# = Eb = [3]_{12}$$
$$E = [4]_{12} \qquad F = [5]_{12}$$
$$C = [7] \qquad A = [9]_{12} \qquad B = [11]_{12}$$

Melodic Inversions

A melodic inversion is a technique that results in a mirror-like imaging of a sequence of notes of music across a horizontal through a specific pitch called axis tone. The result resembles something like the reflection in a smooth pond of the peaks of a mountain range. (In simple words, the inversion of a given melody is the melody turned upside-down.)

If an ascending pattern of notes is inverted or mirrored, the resultant is a descending pattern of notes.

Circle of Fifths

- The circle of fifths is a mnemonic device for organizing the keys by using the hours of a clock. Starting with the key of C at 12:00 and proceeding clockwise, each successive hour is marked with the major key whose signature includes one sharp more than the preceding key.

- So, the key of C has no accidentals, the key of G has one sharp, the key of D has two sharps, and so on. Likewise, if proceeded counterclockwise from C, each successive hour is marked with the major key whose signature contains one flat more than the preceding key.

Mathematical Aspect

Let us denote the original key by x. If an entire musical composition in the key of x is inverted across the pivot note with pitch class p, then the new key, $I_p(x)$ is given by $I_p(x) = [2p - x - 4]12$.

Let the pivot note be F and so $p = 5$. Then $I_5(x) = [10 - x - 4]_{12} = [6 - x]_{12}$

So, if we invert the key of $D(x = 2)$ across F, the result is $I_5(2) = [6 - 2]_{12} = [4]_{12} = E$

Similarly, the key $Ab\ (n = 8)$ is inverted across F to $I_5(8) = (6 - 8)_{12} = [-2]_{12} = [10]_{12} = Bb$

Remark: The keys Eb and A are invariant. The key changes produced by inverting across F can be summarized by the reflection across a diameter through Eb and A on the circle of fifths.

To show: $I_{p+6} = I_p$

$I_{p+6}(x) = [2(p + 6) - x - 4]12$

$= [2p + 12 - x - 4]12$

$= [2p - x - 4]_{12} + (12)_{12}$

$= I_p(x)$

Therefore, $I_p(x) = I_{p+6}(x)$ for any pivot P

$I_5(x) = I_{5+6}(x) = I_{11}(x)$

Hence, the results of inverting across $F(p = 5)$ is the same as inverting across $B\ (p = 5)$.
The diameter of reflection rotates clockwise by $30°$ as p increases by 1.

Consecutive Inversion

Since, $I_p + 6 = I_p(x)$ for $p = 0, 1, 2, 3, 4$, there exists just a distinct inversion 5 which is denoted by $L = [I_1, I_2, I3, I4, I5]$
A way of combining two elements into one is called Binary Operation. Binary operations on numbers I_m and I_n of L by performing them one often the another on a key x is defined as $I_m I_n(x) = I_m(I_n(x))$.
For example, let $m = 4$ and $x = 3$. Then, applying consecutively two inversions on $A\ (x - 9)$ would yield $(I4\ I3)\ (9) = I4\ (I3(9))$.

Recall that,
$I_p(x) = [2p - x - 4]_{12}$

let us calculate

$I_3(9) = [2(3) - (9 - 4)]_{12}$

$= (-7)_{12} = (5)_{12}$

Now, $I_4(5) = [2(4) - 5 - 4]_{12}$
$= [-1]_{12}$

$= [11]_{12}$

Hence $I3\ I4\ (9) = [11]_{12}$
Using notes names for the positions given to us $I3\ I4\ (A) = I4\ (F) = B$
We now verify the previous result with the circles of fifths by reflecting A across $P = 3$ diameter and then across the $P = 4$ diameter. The results yield B as it should.

CONTENT BY: ARUNI SAXENA

LOGARITHM IN MUSIC

We're accustomed to using exponential and logarithmic terms while solving different kinds of equations and have been doing so for a while now. From simplifying differentials to charting a series of graphs, we see these terms everywhere. However, there's a side to logarithmic functions that we may not have been aware of - which is its extensive use across the music industry.

In mathematics, exponents are numbers that indicate how many times to multiply a base number by itself. Logarithms are the inverse of exponents. In contrast, in music, logarithmic scales are used to describe sound intensity and frequency.

Applications of logarithmic functions with a musical perspective:

The Decibel Scale

Named after Alexander Graham Bell, the decibel scale measures the ratio of sound intensities. It is defined as the base 10 logarithm of the intensity of two sounds:

The difference in bels =log10 P1/P2, where P1 is the intensity of one sound, and P2 is the intensity of the other sound.

01

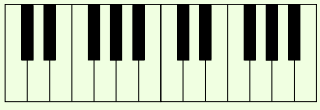
02

Frequencies

The frequencies of musical notes are logarithmic in nature. For example, If a standard C note plays at 256 Hz, the next C — the higher C — the C of the next octave — plays at 512 Hz. The next C would be at 1024, 2048, Hz and so on.

Octaves

In music octaves refer to the measurement of frequency intervals. The difference in octaves is represented by the following formula: Difference in octaves: log2 f1/f2, where f1 and f2 are the two frequencies of the given interval respectively.



03

Interestingly, piano builders place the shape of logarithmic graphs on the body of a piano. This has been known to be helpful in maintaining string uniformity for uniform tuning. Designed to have an equally tempered scale, this ensures that the ratio between the frequencies of any two adjacent notes is the same at every point on the keyboard.

In conclusion, it is safe to say that while seemingly poles apart, the fields of music and mathematics are more interconnected than we could imagine. In fact, the very basic concepts of music composition would fail to exist without the application of mathematics.

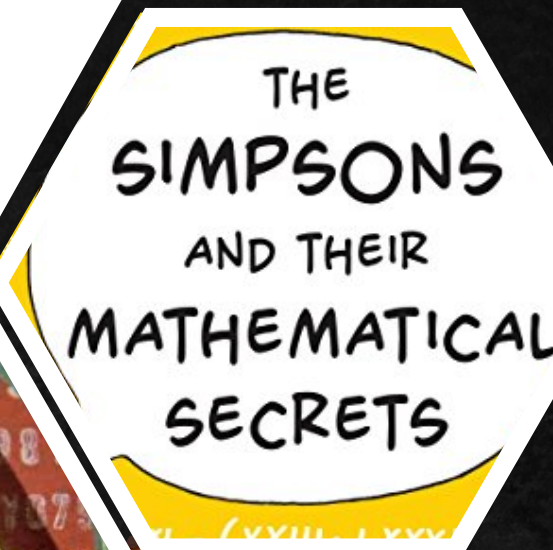
CONTENT BY: SHRUTI OHRI

ALGORITHM RECOMMENDATIONS

Books (Covered) :
Simon Singh: The Simpsons and Their Mathematical Secrets
Fermat's Last Theorem
Godel, Escher, Bach: An Eternal Golden Braid

The Simpsons and Their Mathematical Secrets is a book written by Simon Singh released in 2013.
The beloved television series, the Simpsons, has cleverly embedded well-known mathematical equations, theorems, and conjectures like the Fermat's last theorem, Euler's Identity, primes, 'googolplex', cosmological equation, nature of infinity, and so on, which might not have been noticed by the audience.

In this book, Simon Singh analyses these mathematical concepts in detail and explains how the brilliant show writers, who are maths lovers and at the same time have an unparalleled sense of humour, have smuggled in these mathematical jokes throughout the cartoon's history. With wit and clarity displaying true fan zeal, the book will captivate geeks as well as fans of Simpsons and Futurama!



Fermat's Last Theorem - (Preferred)
Amazon: 4.6 /5
Goodreads: 4.3 /5
Fermat's Last Theorem is a 1997 book written by Simon Singh. The theorem states that there are no natural numbers x,y and z such that x^n+y^n=z^n for n>=3. This book narrates the story of the search for a proof of Fermat's Last Theorem, first conjectured by Pierre de Fermat in 1637, and explores how for over 350 years, many great minds in the world failed to solve this mathematical problem. Finally, in 1993, after years of secret toil, Englishman Andrew Wiles cracked the proof of Fermat's Last Theorem. Simon Singh has crafted a remarkable story of intellectual endeavour spanning three centuries, and a testament to the obsession, sacrifice and extraordinary determination of Andrew Wiles. It's a mesmerising tale which has the power to forever change the reader's thoughts about mathematics, in a positive sense!

Godel, Escher, Bach: An Eternal Golden Braid-
Amazon- 4.5 /5
Goodreads- 4.3 /5
Godel, Escher, Bach: An Eternal Golden Braid is a 1979 book authored by Douglas Hofstadter. GEB won the Pulitzer Prize for general non-fiction and the National Book Award for Science Hardcover. It is an incredible exploration into the nature of intelligence, the human mind, and artificial intelligence. Besides being a profound and entertaining meditation on human thought and creativity, this book looks at the common themes in the lives of mathematician Kurt Gödel, artist M. C. Escher, and musician Johann Sebastian Bach. There are intrinsically fascinating concepts discussed throughout the book like consciousness, recursion, logic, self-reference, maths, metamath, paradox, music, neuroscience and so much more!
The way GEB weaves a tapestry of interrelated ideas is in itself a masterpiece and someone who's interested in complex yet beautiful themes must give it a read.

CONTENT BY: SAUMYA SINHA

Quantitative Insights:

Mathematics in Finance

A sophisticated mathematical model created by experts in the field, such as programmers, statisticians, and financial analysts, is known as a quant investing strategy. The goal is to find stocks with a higher likelihood of outperforming an index by using a variety of factors. Such models and techniques also help with asset allocation and risk management.

Some common quantitative strategies include:

Quantitative value strategy

01

Quantitative Value Strategy: The balance sheet and income statement of a corporation are both used in quantitative value strategy. The model ranks stocks and determines an overall score.It is an investment strategy that aims to identify undervalued stocks using mathematical models. This strategy typically involves:

- Establishing a metric, such as the price-to-earnings ratio (P/E ratio), price-to-book ratio (P/B ratio), or dividend yield.
- Screening for undervalued stocks based on this metric, using mathematical formulas. For example, a stock with a low P/E ratio or P/B ratio may be considered undervalued.
- Optimising the portfolio using mathematical techniques, such as linear or quadratic programming. This involves selecting the optimal combination of undervalued stocks to maximise returns while minimising risk.

Suppose an investor wants to apply Quantitative Value Strategy. The P/E ratio of a stock is calculated by dividing its current stock price by its earnings per share (EPS). If the P/E ratio of a stock is lower than the average P/E ratio of its industry peers, then the stock may be undervalued. The investor can then screen for undervalued stocks by selecting those with a low P/E ratio. Using mathematical optimisation techniques, such as linear programming, the investor can then construct a portfolio of undervalued stocks that maximises expected returns for a given level of risk.

Statistical Arbitrage

02

This strategy uses the relationships between securities to find mispriced securities. Financial ratios are frequently used in this approach to open short and long trades. It is one of the current trading tactics.
Arbitrage strategies can be applied to financial instruments such as
● stocks, ● bonds, ● derivatives, ● commodities etc.

Arbitrage is a risk-free strategy, although this might not always be the case. There is always a possibility of execution risk, i.e. risk due to high volatility in the market and a sudden change in price makes it impossible to close the trade at a profitable price. Other risks involved are counterparty risk and liquidity risk.

There are many risks involved in such strategies such as execution risk, which is risk due to high volatility that results in sudden change in stock price, this makes closing of the position difficult. Some other risks involve counterparty risk and liquidity risk.

Let us take a look at the example now. Suppose a company XYZ's stock trades at $100 per share on the London Stock Exchange and the same stock trades at $105 on the New York Stock Exchange, an arbitrage strategy would be to purchase the stock at $100 on the London Stock Exchange (LSE) and sell it for $105 on the New York Stock Exchange (NYSE), making a profit of $5 per share.

Thus it is recommended to investors to make their own arbitrage strategies ,and count all the factors affecting stock prices and movements in the stock market.

Factor Investing Strategies

03

Factor investing strategies: This technique makes use of one or more factors that have historically helped them outperform a benchmark index. Examples include market cap, value, growth, and momentum. Each stock is given a score based on these factors by the mathematical model, and each stock is then ranked based on the total score.

Multi Asset Strategies

04

It refers to combining several different types of assets into one diverse portfolio. The types of assets could range from stocks and bonds to real estate or cash. One example of the application of mathematics in multi-asset strategy is the use of modern portfolio theory (MPT) to construct an optimal portfolio. MPT uses mathematical optimization techniques to identify the combination of assets that maximises expected return for a given level of risk.

For instance, an investor might use MPT to allocate their assets among stocks, bonds, and real estate to achieve a target return while minimising the risk of loss.

As with everything in the world, there are also some cons to this type of investing strategy. For example, even highly advanced models at this stage cannot make decisions taking qualitative data - such as management style or corporate scandals - into consideration while making an investment decision. Such factors would definitely affect a person's mind in making a judgement regarding investing into certain stocks. Additionally, as they are based on probabilities and expected returns, quantitative methods need a lot of holdings. Also, they require lengthy periods of time to perform, and if given a shorter time frame, they will certainly underperform.

CONTENT BY: ATIPRIYA DEV SINHA

The Department of Mathematics

Report

2023 AT A GLANCE

ALUMNI TALK

The Department of Mathematics organised an Alumni Talk on 18th February 2023 at JMC campus. The session was on the topic 'Crack Jam'24 with Top Insights' , taken by our alumni Ms. Alisha Arora- Consultant at DHL Supply Chain Pvt. Ltd., Mumbai and Ms. Richa Dhingra- Specialist at Mc Kinsey knowledge Centre, Gurgaon. They gave useful tips to the students on how to crack IIT JAM and even discussed some future career prospects after mathematics. For example, career in Operational Research. The talk was followed by a fruitful QnA session where the students clarified their doubts.

FRESHERS 2023

The Department of Mathematics organised a 'Retro' themed Fresher's Party on 20th January 2023 to welcome the incoming batch of brilliant minds. The freshers dressed up in their favourite retro costumes, radiated golden era vibes.

The event saw beautiful performances by seniors, followed by a ramp walk and then a talent hunt round where the freshers showcased their artistic skills. The occasion came to an end with the declaration of the results- Lavanya Singh won the title of Ms. Mathematics with her powerful classical performance and Ritika Gandhi won the title of Ms. Personality for her soulful guitar and singing performance. As a token of love, the seniors gave gifts to the juniors.

MATHARENA 2023

On March 23rd 2023, the Department of Mathematics conducted its annual fest Matharena in offline mode after three years. The fest commenced with the lighting of the lamp by our chief guest, Prof. Swarn Singh (from the Department of Mathematics, Sri Venkateswara College) who then enlightened the students about the art of discovering the connection of Mathematics in everything such as the Black-Scholes model, the Kargil War and the Russia and Ukraine War.

This was followed by the Paper Presentation competition where participants started presenting their respective research papers. After each presentation, questions from the audience were taken. The top three teams were awarded with cash prizes, certificates and gift hampers, and a special award was given to the best Interjector.

The next event was the quiz competition. 20 teams of either lone wolves or teams of 2-3 people were shortlisted from a whopping 180 teams that registered. The offline competition consisted of two rounds, the first of which was an MCQ round. Six teams were then chosen to compete in the rapid fire round on stage in the second round. Scores from this round were computed to award the first three teams who were declared as winners. The Department of Mathematics also collaborated with Tabeer, the Photography Society of JMC to hold a photography competition and with Puzzle Society JMC to host the challenge "Math Maze: The Puzzle Mania". In the first competition, the participants were shortlisted based on their online submissions and, for the second round, had to click photos on the campus in accordance with the theme. In the second competition, over 120 teams participated in an online quiz held two days before Matharena and 16 teams were shortlisted to participate in the second round, which was an Escape Room.

The final event was the open mic, which was judged by singer and influencer Mr. Kashsish Anand. Students presented their various talents!

The day finally concluded with the closing ceremony where the Head of Department, Dr. Rashmi Thukral imparted words of wisdom and the Vice President of the Department presented the vote of thanks.

SPORTS DAY

During the Sports day which was organised by the college on 2nd March 2023, the students of the maths department enthusiastically participated in the march past and the events. Prashita Verma backed 1st in 400m, and 3rd in 100m and 200m and also won the best athlete award.

ACHIEVEMENTS

Manasvi Mitra -	won the 2nd prize it the poster making competition organised by Green society. The Vice President of DigiLit- The Tech and Digital Literacy Society and am also the subhead of Events and Research at math dept
Muskan Babbar-	was in the Top-5 of the EY CAFTA Case Champiyonship 2022.
Shreyasee-	got selected into Pepper content as a freelancer through placement cell
Elizabeth Mohan-	was awarded by the Delhi Commission for Women. Government of NCT Delhi on the occasion of International Women's Day for my contribution in NCC with a cash prize of Rs 50.000/-. 90 women from all over India from various fields were awarded during the ceremony.
Khyati Sharma-	Elected as Vice President of Chanakya.The Economics Cell. JMC in September 2022
Jeffy Sabu-	backed third position in a quiz competition conducted by the dept of history. DCAC
Aditi Varshney and Anjali Batra-	First position in maths quiz and third position in maths maze during matharena 2023.
Aruni Saxena-	I.) Secured Ist Position in Mathematics. Paper Presentation Competition held at Maitreyi College. based on Interdisciplinary Nature of Mathematics. 2.) Secured 2nd Position in Mathematics. Paper Presentation Competition. based on Calculus and its application in modern day life along with geometry and its significance in ALPHA 23. the Annual Fest of the Mathematics Department of Hindu College. 3.) Secured 3rd Position in Mathematics. Paper Presentation Competition. titled Ubiquitous Maths (solving real world problems through mathematical lens) in Mathrena 23. the Annual Fest of the Mathematics Department. Jesus and Mary College. 4.) Presented the paper and Qualified for the All India Top 15 Research papers at IIT Hyderabad as a part of Elan & ηVision 2023.
Prashita Verma-	won the Best Athlete Award during sports day 2023 Backed Ist in 400 m gold. 3rd in 100m and 200m
Devika Raaj Gupta &Vandana Kothari-	2nd position in Ad-Mad Competition organised by Department of Commerce. JMC

FACULTY

Teacher in Charge: Dr. Rashmi Thukral | Association In Charge: Dr. Shruti Tohan

Dr. Alka Marwaha	Ms. Rama Saxena	Dr. Shiva Kapoor	Dr. Priyanka Goel	Dr. Ambika Bhambani
Ms. Sunita Narain	Dr. Anu Ahuja	Dr. Shikha Singh	Ms. Richa Krishna	Dr. Indrakshi Dutta Dr. Monica Rani

OFFICE BEARERS

President	Vice President	Treasurer
Devika Raaj Gupta	Tahira Khan	Vandana Kothari

Musings

Prompt taken- "I prove a theorem and the house expands :the windows jerk free to hover near the ceiling, The ceiling floats away with a sigh." - Geometry, Rita Dove

I prove a theorem and the house expands:
the windows jerk free to hover near the ceiling,
The ceiling floats away with a sigh." -
And a crack occurs in its foundation
As the hollow spaces occupy the closed gaps between cemented bricks
And I feel something light take birth within
As if giving wings to an injured bird.
My feet sway in an atmosphere of definite substances and unadulterated deductions, while
My head hovers amidst a vast expanse of cloudless skies
Not daring to look beneath where I stand, and beyond where my gaze wanders through.
The parallel lines found an intersection, and the circle embraced its starting point,
Am I wrong to have travelled through the path of what used to exist in oblivion?
I feel a zephyr entangle the strands of my voluminous hair, and wrap around my feet
Like a blanket offering furry warmth.
I have found an answer of my own making, one built upon structures that align with my mind's curiosities, forever attempting to discover and rationalize.
My mother used to often say, "shapes, letters and numbers are all incarcerated creatures, confined within definite boundaries. Even hope becomes desperate for hope."
To me, their incarceration appeared like a butterfly set free from the spider web, the boundaries representing a home for lonely men,
All brought together by the belief that there exists a place, where all are in search of a single attestable answer.
Albeit, I was never told that diversity does not have parallel lines or points of intersection
That, rules lose all stability when humans become its victims, instead of stagnant digits and placid letters.
Theorems could be read like poetry, one step leading to the next, its pace resembling those of mechanized movements;
However, they intersected at a single point, only to become ill-fated lovers, destined to disentangle all threads of their transient entanglement.
So now, I feel the the corners of the house becoming round, closing in on me, and disappearing into shadows of nothingness,
For a while, I thought I was being chased for having committed an inane error, as often happens while looking for a plausible solution.
But, the windows that floated near the ceiling had already been devoid of all boundaries,
And the glass ceiling had been crumpled into a thin sheet of paper, marked by fine wrinkles all across.
The crack was perhaps,merely the sound of the cackling fire as deviating choices and shifting differences were burned in ashes,
And the smoke birthed eccentricity, making uniqueness the only identifiable principle.
The spirits of naked beliefs and unclad assumptions drowned into blissful oblivion, as I became the sole audience to the revelation of an abstract being.
Maybe, I was still far from the boundaries of truth.
Maybe, the boundaries were only a mirage to feed my shattered soul

Maybe, the lonely men are not looking for answers built on proofs,

but simply for people
Entrapped in a shared world of maybes.

-Zunairah Husain
(I position, Mathematical Verses Competition)

Musings

Peek-a-boo with Inevitable

It's the Inevitable.

The fact that it will come around even if you try to avoid it,
to fight it with the most rational or irrational moves;
it would be there,
looking you straight in the eye, with the most readable expression
but you'll call yourself an illiterate in that moment
and put your last hope at stake.

For it is the Inevitable.

That's what hurts,
that's what changes and
that's what brings you to conclusions and assumptions
and doubts and truths,
but most importantly, it brings you to reality -
reality you try to fight against,
fate you try to change,
hearts you try to mend.

You try accepting the Inevitable.

This realization of fighting a losing battle doesn't help,
it adds to it -
in exponentials that are unfathomable,
in languages that are ineffable and
in pain that, no matter how hard it tries,
always find its way back to you.

You start living with the Inevitable.

There's a coming closer, a narrowing gap.
An end to everything you wish, lingered.
It brings the nonchalant in you and
the you who wants to hide away;
you, who desires to disappear in thin air
and the you, that just wants everything to end.

The Inevitable is sleeping on your couch so, you ask it to make some space for you.

"But it was enough," you tell Inevitable or rather, yourself.
Enough for you to have shared the same sky.
Enough to the almost -
almost of all and
almost of none.

-Pratima Singh
(II position, Mathematical Verses Competition)

Musings

Prompt taken- “Infinite is a meaningless word: except - it states / The mind is capable of performing / an endless process of addition.”

Soulmates

Infinite holds meaning only in a promise,
Of people hoping to remain together forever;
Promises that are added one after another,
But their sum total imagined seldom, if not never.
For, there exists no infinite bond,
Though it may be true that it never breaks.
Time might not cooperate as per one’s whims,
But what exists now definitely exists for love’s sake.
“Would you hold my hand in the next birth too?”
No such doubt among soulmates, you could say,
Being convinced of the union since conception, and,
Assuring them that for all the rebirths yet to come,
Together you would always stay.
If only there was such a loop to be believed,
If only there was a yesterday or a tomorrow,
If only this moment wasn’t the solely one to claim,
We wouldn’t have needed a lifetime to borrow.

-Anika Chowdhary
(III position, Mathematical Verses Competition)

Class of 2023

Aditi Varshney

"Will be missing these days!"

Saumya Sinha

These 3yrs of college life....oh I mean 1.5yrs, have been fabulous! :')"

Anjali Batra

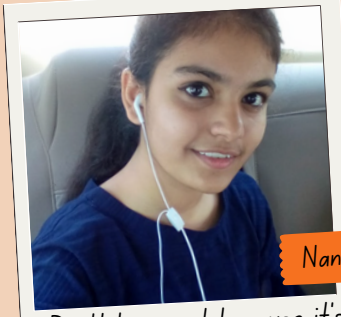
Endings are tough but... Zendagi migzara!"

Yakshi Verma

It's not goodbye. It's see you later ! ☆☆

Shreya Chaturvedi

Beautiful part about life is that it's messy. Don't try to sort it, learn to live it.



Nandini Khatri

Don't be upset because it's over, smile that it happened.

Rebekah Jasper

Fearfully and wonderfully made

Megha Treasa Joseph

Live life the way it comes and always be happy!

Vidhi Sharma

I regret nothing. Not even this photograph..

Devika Raaj Gupta

It's okay to not be okay but it's not okay to stay that way..

Prachi Indira

"To boldly go where no one has gone before"

Krishna Nair

"Pricey coffee is never worth it"

Atipriya Dev Sinha

"...but my best is what comes next."

Vasundhara Awasthi

They asked me to write anything. So here it is: Anything

Shruti Ohri

Here's to what we thought was going to end up being a degree dot pdf.

Monisha Jasrai

I don't know how I'm here or why I'm here or what is here

Japita Singh

"There's nothing we can't do if we work hard, never sleep, and shirk all responsibilities from our lives."

Kushmita Sharma

"Welcome to the real world. It sucks. You're gonna love it"

Anamika Basu Thakur

'Love yourself, love myself, peace

Nandika Aggarwal

No amount of concealer can hide how tired I am of this degree.

Parissa Tripathi

Only ever came to college for the aesthetics.

Riddhi Sehgal

"I don't know about a specialisation in math but I've definitely got one in shedding tears now"

Karthika Suresh

Haan haan chall theek hai...

Aruni Saxena

And Miles to before I sleep.....A sincere NCT resident

Greetings!

2

Elizabeth Mohan

Relax.Recharge.Reflex. Sometimes it's okay to do nothing.

Jeffy Sabu

Remember to live in your present moments and savour all the little joys in it.

Jennifer Tresa TItus

"I am a bit of a unicorn."

Maher Sondhi

So no one told you life was gonna be this way....

Aishwarya Mohan

Your job's a joke, you're broke.

Aan Maria James

Your love life's DOA

Isha Bisht

It's like you're always stuck in second gear

Stephy James

When it hasn't been your day, your week, your month or even your year

Priyanka Jeswani

I'll be there for you, when the rain starts to pour

Vashima

I'll be there for you (Like I've been there before)

Divya Bahl

I'll be there for you (Cause you're there for me too)

Nehal Singh

All the things I love is what my business is all about.

Rishika Verma

Dear Maths, Please grow up and solve your own problems, I'm tired of solving them

Kashish Khullar

Bhaiya's sevpuri is not that good. Not sorry

Prashita Verma

Never settle for less and ordinary, you're more than what you know you're.

Lavanya Grover

Just finished my 3 year sentence

Khushi Jain

Sometimes you have to get rid of the old to welcome all the good new things !!

Radhika Aggarwal

Two hardest things to say in life, Hello on the first day and goodbye on the last!!

Shreyasee Choudhury

Sources of joy are scattered everywhere... it just takes one to find it!

Diya Thakur

The only thing lower then my SGPA is my will to LIVE.

404

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Sub-Editor-In-Chief
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