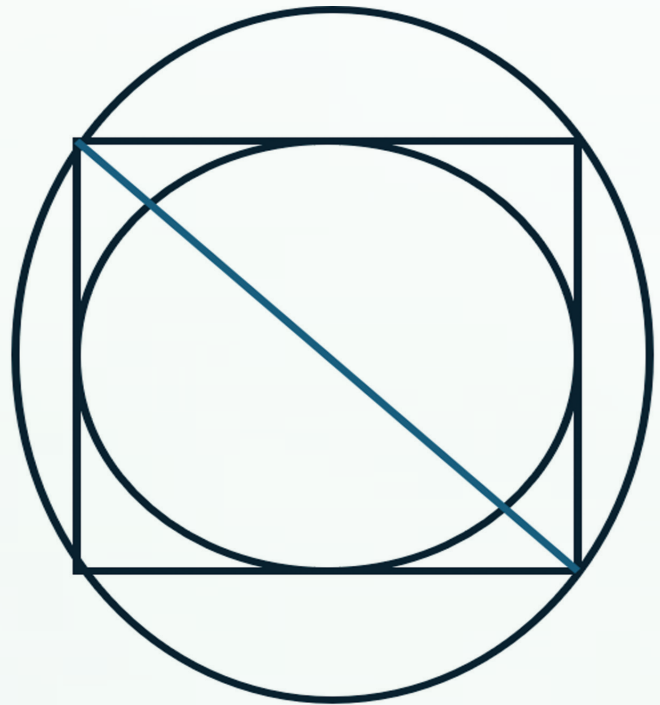


Oh, I am Pi!

Surbhi Dahiya

Every year, March 14 is celebrated as Pi Day, and it is because Pi is written as 3.14 in the simplest form, which relates to 3 (March, Month), and 14 (Day). At the 40th General Conference of UNESCO in 2019, this day was designated as the “International Mathematics Day.”



P^I (denoted as Π) is not just an ordinary discovery or a number; it is mysterious and scientific in nature. Pi is calculated as a ratio of the circumference of a circle to its diameter, and the basic fact that emerges is that no matter what the size of a circle is, the value does not alter, which makes Pi a significant mathematical constant. Another noteworthy mystery that is related to it is that it is an irrational number with no repeating or recurring numbers or any pattern after decimal. However, some sub-patterns are seen; at position, 17,387,594,880, one can find digits 0123456789 in order; at position 60, these numbers are in jumbled form; at position 768, there are six nines in a row. Miraculous behaviour!

Why is Pi celebrated across the world and considered a mysterious number? It is because it is encoded in one or the other form in the universe through a variety of expressions. In

a very crucial observation, it was found that if the actual length of a river is divided by the straight-line path of a river, which is called sinuosity, describing how bendy a river can be, it was found that the average sinuosity of all natural rivers came out to be Pi. Interesting! Pi has certain characteristics, like it is transcendental in nature, meaning it cannot be calculated by simple operations like subtraction, addition, multiplication, division, or square root extraction.

Delving into the history of Pi, it is known from almost 4000 years ago. It is said that the first calculations were done by Babylonians, who calculated the area of a circle by taking three times the square of its radius and giving the value of $\Pi = 3$. Years later, Babylonians performed more calculations, and this value reached 3.125, making it closer to the contemporary figure. Nearly 1650 BC, Egyptians used a certain formula for circle and made it to 3.1605 for Π . The other way of

calculation was performed by Archimedes, approximating the area of the circle using Pythagoras Theorem. He used two regular Polygons for these calculations by inscribing one circle inside one polygon and another polygon inscribed inside the circle. Through this, he showed that he did not calculate the actual value of Π . However, he predicted that its value would lie somewhere between $31/7$ and $310/71$. Indians have been significant in contributing towards this value. The first value of approximately 3.088 comes from the source Sulvastura near about 800 BC, whereas around 600 BC, Satapathabrahmana reports it to be 3.125, correct up to one decimal number. Aryabhata gave the value of Π around 499 CE and found it to be correct up to 4 decimal places. It was in 1706 that William Jones made Π as the symbol representation of this number. Its transcendental nature makes it unique, which was first proved by Ferdinand von Lindemann in 1882, who used Euler's identity $e^{i\Pi} = -1$, stating $i\Pi$ to be transcendental. Since i is algebraic in nature, hence Π is transcendental in nature. Srinivasa Ramanujan, an Indian Mathematician derived a mathematical infinite series that was the fastest way to calculate the value of Π .

Π has its significance in several mathematical problems, from calculating the area of ellipses and sectors to the volumes of solids. It finds applications in understanding the periodic motions associated with pendulums, strings as well as alternating electric currents. However, for the elementary level calculations, Π is taken as $22/7$, which poses a major drawback when studying the structures of complexity like buildings, MRI machines, modelling and simulation on software that works with precision and accuracy and yearns for earnest values of Π after the decimal. Some calculations need trillions of values of Π after decimal for the decoding of accurate information.

The importance of Π is not limited to mathematicians; however, physicists, biologists, space scientists, material scientists, etc., have developed their mechanisms to understand how Π fits in their domain. From basic kinematics to understanding quantum physics, Π plays a major role. In studying the uniform circular motion, the angular velocity (ω) is given by $2\Pi f$, where f is frequency, whereas for studying the Biot-Savart Law that describes a magnetic field created by an electric field, the magnetic field is represented by making use of Π . The time-period calculations around a central mass derived from Kepler's law again make use of Π in calculations. In the Harmonic oscillator, the calculation of the time period is given by $T = 2\Pi\sqrt{1/g}$, stating that it also contains Π . Similarly, studying Columb's law or Heisenberg's Uncertainty principle, all comprise Π for their relevant calculations. It also plays an important role in studying the nature of light and sound in a more peculiar and precise way.

In life sciences too, Π plays a significant role. It is said that life is also a number! In understanding the longevity of life, biologists use the volume of the heart or lungs for imaging and understanding the physiological behaviour of these organs. In decoding the electrocardiograms, which

measure the electrical activity of the heart, Π helps in analyzing the ECGs that use the Fourier series. Circles and spheres that make use of Π for the calculations, find their way in biology as several shapes of viruses and bacteria resemble mathematical figures. Folding of proteins, enzyme activity, and DNA replication understanding is not possible without the value of Π . In 1952, Alan Turing proposed that the pattern formation during morphogenesis is encoded in the form of Π .

Studying Π without Quantum Mechanics would not be justified. Schrodinger equation (a partial differential equation of a non-relativistic quantum mechanical system) works on the principle of quantum mechanics, making use of Π for calculations. In 2015, Tamar Friedmann and Carl Hagen used the "Wallis formula" to determine the energy states in the hydrogen atom. Wallis formula was given by John Wallis that defines Π as the product of an infinite string of ratios made up of integers. Though Neils Bohr gave the accurate formula for calculating the states of the hydrogen atoms, Hagen used an alternative approach called the variational principle to understand the ground state of the hydrogen atoms. This led to the beautiful synergy between Π and quantum physics to go deep in figuring out the discovery at the atomistic level. There is still a need for studying these calculations to understand the excited state of an atom, rather than just fixing it to ground level.

Today, AI is making use of Π for its high-level mathematical calculations through its model networks. It can help calculate the value of Π to a significant decimal place as well as use Π for other daunting tasks. In neural networks, the use of Π is defined in a more structured way called a " Π -sigma" network for unique calculations in performing non-linear computations. Such Π -sigma networks not only perform mathematical calculations but are used for determining stock prices, weather forecasting, customer-sales relationships, etc.

Π , a fundamental constant of mathematics, is not just limited to one subject; however, it finds its importance in every domain of the universe, sometimes in the form of patterns or codes, and sometimes directly in the form of trigonometry, circles, formulae, etc. Its value helps in understanding the mysteries of the universe through astrophysics, the behaviour of human beings through biological importance, and modern-day artificial intelligence. It plays an important role in black hole physics, simultaneously leading to new discoveries in algorithms, probability, complexity, economics, etc. It is studied in Monte-Carlo calculations, depicting computational simulations at the molecular level in Chemical Engineering and other sciences. Today's encryption technology owes its importance to Π in a significant form. The future will look for better calculations in the value of Π and fix this through modern computers and calculators for application in different fields of research.

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