BLAISE PASCAL'S CONTRIBUTION TO THE EMERGING FIELD OF PROJECTIVE GEOMETRY

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Abstract: - Blaise Pascal (1623 – 1662) was a French mathematician, scientist, religious philosopher and writer. Pascal came up with Pascal's Theorem at the age of 16 and before he turned 20, he had also invented the world's first fully functional mechanical calculator. Blaise Pascal and Pierre de Fermat, two French seventeenth century mathematicians, founded the field of mathematical Probability and how this area continued to evolve after their contributions. Pascal worked extensively in many fields of mathematics including the development of the still famous Pascal's Triangle. This Triangle has its cornerstone in probability, but it also arises in statistics, algebra, calculus, combinatory, and more fields.

Introduction: - when he was sixteen he wrote and presented a paper written by him which contained many projective geometry theorems such as the well-known 'Pascal's mystic hexagon'. He invented the first digital calculator after working on it for three years. He named it the 'Pascaline'. His invention was displayed in two museums` in Paris and Germany. Meanwhile Pascal worked on various theories including that of the atmospheric pressure. He worked a great deal in 'hydrodynamics' and 'hydrostatics. One of his inventions besides the Pascal's calculator was the hydraulic press and the syringe. He proved the existence of vacuum above the atmosphere. Projective Geometry is a branch of geometry dealing with the properties and invariants of geometric figures under projection. At the age of 16, Blaise Pascal produced a short treatise titled Essai pour les coniques (Essay on Conics) in the emerging field of projective geometry. The essay includes what is now known as Pascal's Theorem. It states that if a hexagon is inscribed in a conic section then the three intersection points of opposite sides lie on a straight line; referred to as the Pascal line. Pascal's Theorem was his first important mathematical discovery and a breakthrough contribution in the field of projective geometry.

- **Contribution to Mathematics:-**

Pascal had a great influence on mathematics. 'Pascal's triangle' (1953) and 'Pascal's theorems' are two examples of the many influences that Pascal made to this field. Pascal was inspired by his friend who had a big interest in gambling and introduced the concept of probability and the idea of expected value was presented. One of the major contributions of Pascal includes his textbook written for a school 'Petites-Ecoles de Port-Royal'. It was 'De l'Esprit géométrique' which means 'Of the Geometrical Spirit'. This work of his was however published a century after his death. It was Pascal's work on 'binomial coefficients' that guided Newton to discover the binomial theorem.

- **Pascal: Probability and Beyond** :-

Pascal and his friend Fermat wrote letters to each other from July – September of 1654 discussing the problem of the points. Before discussing what Pascal and Fermat accomplished on this problem, it should be noted that this problem had a long history – and is important in discussing why Pascal and Fermat were the first ones to solve it. It has long been recorded that gambling has been a part of every major society in history, from the ancient Egyptians, ancient Greeks, ancient Romans, all the way up to Pascal and Fermat's time in seventeenth century France. However, "up to the time of the Renaissance, people perceived the future as little more than a matter of luck or the result of random

variations" and no one thought that the games of chance they played could be predicted or contain a specific number of possibilities.

- **Blaise Pascal Invented the World's First Fully Functional Mechanical Calculator**

In 1639, Pascal's father Étienne was appointed commissioner of taxes in the city of Rouen. To help his father in laborious tax calculations, in 1642, Blaise Pascal constructed a mechanical calculator capable of performing addition and subtraction directly; and multiplication and division through repeated addition or subtraction. Known as Pascal's calculator or the Pascaline, it was especially successful in the design of its carry mechanism, which adds 1 to 9 on one dial, and when it changes from 9 to 0, carries 1 to the next dial. The Pascaline was world's first fully functional mechanical calculator, and in 1649 Pascal received a royal patent on the device. A few decades before Pascal, German professor Wilhelm Schickard had made a failed attempt at mechanizing calculation.

- **He did Important Work Concerning Atmospheric Pressure and Vacuum:-**

In 1643, Italian physicist *Evangelista Torricelli* filled a glass tube with mercury and inverted it into a column of mercury thus inventing the barometer, which is used to measure atmospheric pressure. Torricelli surmised that the space at the top of the tube was a vacuum. However, scientists of the time were adamant that the existence of vacuum was impossible, as such had been stated by Aristotle. On learning about Torricelli's experiment, Blaise Pascal devised his own experimental set up to test the results. Pascal published his findings in his 1647 work Experiences nouvelles touchant le vide ("New experiments with the vacuum"). In it he gave detailed rules to describe to what degree various liquids could be supported by air pressure. It also provided reasons why it was indeed a vacuum above the column of liquid in a barometer tube.

- **Pascal Rediscovered that Atmospheric Pressure Decreases with Height:-**

The decisive experiment, proving that the level of mercury in the tube was due to external atmospheric pressure, was conducted at the Puy-de-Dôme, a large lava dome in central France. However, as Pascal was not well, it was conducted by his brother-in-law Florin Périer. Two identical barometric tubes were used. The first tube remained at a base point in the town where a team monitored its readings; while the other barometer was carried up a mountain. While the reading in the first tube remained constant, mercury level in the other tube decreased with elevation. Thus Pascal rediscovered that atmospheric pressure decreases with height. Though the scientific community accepted his results regarding the inverse variation of atmospheric pressure with altitude, they still insisted that some invisible matter existed above the mercury in the tube. Still, Pascal's work did advance acceptance of the reality of vacuum.

- **He Discovered the Influential Pascal's Law in Hydrostatics:-**

In 1647, Blaise Pascal discovered what is known as Pascal's Law or Pascal's Principle. It states that pressure applied to a confined liquid is transmitted undiminished through the liquid in all directions regardless of the area to which the pressure is applied. Pascal's Law is one of the most important discoveries in hydrostatics and it is the underlying principle of the hydraulic press which uses hydraulic pressure to multiply force. Hydraulic press is used in many devices including the hydraulic jack and the hydraulic brakes in vehicles. Pascal also invented the syringe as an application of his principle.

- **His Contributions to Hydrostatics:-**

Two detailed studies by Blaise Pascal, Treatise on the Equilibrium of Liquids and Treatise on the Weight of the Mass of Air, were published after his death and are considered seminal contributions to the sciences of hydraulics and hydrostatics. The former includes his Pascal's Law and is regarded as the first classic in hydrostatics. Due to Pascal's experiments with the barometer, his influential principle and his other work in hydrodynamics and hydrostatics.

- **Pascal was one of the Pioneers of the Theory of Probability:-**

Blaise Pascal is one of the most well known mathematicians. In 1654, he corresponded on the subject of gambling problems with his friend Pierre de Fermat, a lawyer, an amateur mathematician and a noted gambler. Together the two correspondents effectively founded the modern theory of probability, thus strongly influencing the development of not only mathematics but also other fields like economics and social science. Their work into the calculus of probabilities was also helped Leibniz' formulation of calculus. In his unfinished work Pensées, Pascal used a probabilistic argument, Pascal's Wager, to justify belief in God and a virtuous life. Pascal's development of probability theory is considered his most influential contribution to mathematics.

- **Pascal's Triangle in the Western World:-**

In his 1653 mathematical work Traité du triangle arithmétique (Treatise on the Arithmetical Triangle), Pascal described a convenient tabular presentation for binomial coefficients, now known as Pascal's triangle. Indian mathematician Pingala was the first person to present the Pascal's triangle by 2nd century BC and it was known to other cultures including China. However, Pascal did make it famous in the Western world and hence it bears his name. In 1654, he proved Pascal's identity, relating the sums of the p-th powers of the first n positive integers for p = 0, 1, 2, k. Other contributions of Blaise Pascal to mathematics include his works De l'Esprit géométrique ("Of the Geometrical Spirit") and De l'Art de persuader ("On the Art of Persuasion").

- **The Influential Work Provincial Letters:-**

Blaise Pascal had an intense religious vision in 1654 after which he focused his talents almost exclusively on religious writing. Between January, 1656 and March, 1657, Pascal published a series of eighteen letters to defend the Jansenist community of Port-Royal against the Jesuits, who accused them of heresy. These are now known as Provincial letters. In the Provincial letters, Pascal denounced casuistry as the mere use of complex reasoning to justify moral laxity and all sorts of sins. The reaction to the letters was substantial; and Pascal's use of wit, humor and mockery in attacking existing institutions made the work extremely popular as a literary masterpiece. Though King Louis XIV ordered the book to be destroyed, it survived and went on to influence the prose of later French writers like Voltaire and Jean-Jacques Rousseau.

- **His Work as a Landmark in French Prose:-**

Blaise Pascal's most influential theological work was not completed before his death in 1662 at the age of 39. It was referred to posthumously as the Pensées. The Pensees contained a detailed and coherent examination and defense of the Christian faith. It first appeared in print in 1669 and soon became a classic. The Pensees is widely considered to be a masterpiece and a landmark in French prose. Due to his great literary works, the Pensees and Lettres provinciales, Blaise Pascal is regarded as one of the most important authors of the French Classical Period and one of the greatest masters of French prose. He is also considered by many as an early pioneer of existentialism, a philosophical theory centered on analysis of individual existence.

Conclusion: - Pascal and Fermat are two mathematicians whose theories have definitely withstood the test of time. Both of them revolutionized so many areas of mathematics, and further helped develop new areas of mathematics that both of them could never have dreamed of. Religion impacted both mathematicians, with Pascal in more overt ways, and Fermat much less so – he seemed to exist in a more protected sphere, as he came from a wealthy family and worked in a government position that was relatively shielded from the reach of the Church. Pascal died on 19th August 1662 in Paris. Honoring his immense scientific contributions the SI unit of pressure is named Pascal as well as to a programming language. Pascal's Law is another example of the respect he has earned in the scientific world.

Reference:-

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