

The Euler enigma

Leonhard Euler's works continue to evince interest even in his 300th birth anniversary year.



Leonhard Euler, one of the greatest mathematicians of all times was born near Basel in Switzerland around mid April 1707. He was most prolific, having written over eight hundred papers and books. About two-thirds of it was in mathematics and the rest covered physics, astronomy and even engineering. What is remarkable is that many of these works were written when he became completely blind!

On several occasions, he wrote more than 50 papers in a single year and it took the St. Petersburg Academy 79 years to publish the inventory of over 300 papers that were left behind after he died. He practically invented the subjects of number theory and topology. Euler's name is tied to at least eighty different things named after him including theorems, concepts, formulae, equations, angles, functions, lines, constants and points, populating all branches of maths and physics!

The most famous Euler formula is: e to the power of i times π , plus one equals zero. e is the base of natural logarithm, i is the square root of minus one, π is the ratio of circumference of circle to its diameter. This beautiful formula connects the most important numbers (used in all areas), that is, e , π , i , one and zero! Euler did not actually write it in that form,

but that was the relation he had.

The Euler constant, another beautiful number arises in the divergence of the harmonic series and the Euler index comes in topology being 2 for a sphere (explaining the relation $\text{vertices} + \text{faces} = \text{edges} + 2$ for all the regular polyhedral). He found the beautiful series connecting the Riemann Zeta function and the prime numbers. There are any number of Euler formulae in pure mathematics, including studies of differential equations.

His papers laid the basis for whole fields like fluid flow, mechanics of rotating bodies, celestial mechanics, marine engineering, optics, civil engineering and what not!

He published a two-volume work on mechanics in 1736 (reformulating kinematics and dynamics analytically by calculus including motion on a curved surface). In 1765, he wrote another two-volume work on theory of motion of solid bodies. This contains much of what university physics students learn today in upper level courses. Some of these topics are Euler angles, rotational moments of inertia, torque and the precession of gyroscopes. Aircraft, rockets and satellites extensively use his formulae today!

Euler's work on the lon-

gitude problem finds application in space navigation and positioning of satellites. In 1774, well after going blind, he presented a long paper in optics to the Russian Academy of Sciences. It was published without review and dealt with the problem of chromatic aberration in lenses. He had earlier proposed an 'achromatic' device based on lenses with different optical densities, which was actually put into practice by the optician, John Dollond. His 1774 paper presented a complete analysis of the technique to design achromatic devices.

The Euler column tells civil engineers and architects the maximum load a given strut or pillar can withstand. It has also been applied to trees bending in the wind and other related problems in biomechanics. His patron, Frederick, the Great of Prussia, asked Euler to translate the best book on ballistics. Euler chose the book by Benjamin Robins and adding his notes, expanded the book to four times its original length. He made detailed studies of actual trajectories of cannon balls, checking his work with experimental data! His works on fluid mechanics was applied to the design of pumps and fountains. Euler helped to invent the centrifugal pump and even designed a water turbine that is efficient even by current standards!

Even after going fully blind, he wrote books on integral calculus, ship buildings, the philosophy of science etc.

On the day of his death, on September 18, 1783, he was busy working on equations for the buoyancy of hot-air balloons, flown earlier that year by the Montgolfier brothers. The previous day, he had worked on the orbit of Uranus, discovered in 1781. His students later published that afternoon's calculations on hot-air balloons in Euler's name!

C SIVARAM