**History of Mathematics (Early AD – 1900)**

* **Early AD – 1100**
  + Diophantus of Alexandria *(c.200-284 CE)*
    - Greek or Egyptian
    - Known as “the father of algebra”
    - Wrote a series of books “Arithmatica”
    - <https://www.storyofmathematics.com/hellenistic_diophantus.html/>
  + Aryabhata *(476 – 550 CE)*
    - Indian
    - Place value system and zero
    - Approximation of
    - <https://en.wikipedia.org/wiki/Aryabhata>
  + Omar Khayyam
    - Persian
    - Classified cubic equations: (i) equations which can be solved with [compass and straight edge](https://en.wikipedia.org/wiki/Ruler_and_compass" \o "Ruler and compass), (ii) equations which can be solved by means of [conic sections](https://en.wikipedia.org/wiki/Conic_section" \o "Conic section), and (iii) equations which involve the [inverse](https://en.wikipedia.org/wiki/Multiplicative_inverse" \o "Multiplicative inverse) of the unknown.
    - Linked algebra to geometry.
    - <https://en.wikipedia.org/wiki/Omar_Khayyam>
* **1100 AD – 1200 AD**
  + Bhāskara II (1114 - 1185)
    - Indian
    - Proved the Pythagorean Theorem
    - Explained solutions of quadratic, cubic and quartic indeterminate equations.
  + Fibonacci (1170 - 1250)
    - Italian
    - Introduced Hindu-Arabic numerals to Europe in *Liber Abaci*
    - Famous for Fibonacci sequence
* **1200 AD – 1300 AD**
  + Nasir al-Din Tusi (1201 - 1274)
    - Persian
    - Many consider he to be the father of trigonometry.
    - Al-Tusi was the first to write a work on trigonometry independently of astronomy.
  + Yang Hui (1238 - 1298)
    - Chinese Mathematician
    - studied magic squares and magic circles, the binomial theorem, quadratic equations, as well as *Yang Hui’s triangle* (known in Europe as Pascal’s triangle).
    - Yang also wrote geometric proofs, and was known for his ability to manipulate decimal fractions.
* **1300 AD – 1400 AD**
  + Nicole Oresme (1323 - 1382)
    - French mathematician
    - Invented coordinate geometry, long before Descartes, was the first to use fractional exponents.
    - Worked on infinite series.
* **1400 AD – 1500 AD**
  + Luca Pacioli (1447 - 1517)
    - Italian
    - Invented the standard symbols for plus and minus.
    - Pacioli collaborated with Leonardo da Vinci, and also wrote about arithmetic and geometry.
  + Leonardo da Vinci (1452 - 1519)
    - Italian artist and polymath.
* **1500AD – 1600AD**
  + Nicolo Tartaglia ( 1499-1559)
    - Italian mathematician
    - Tartaglia is famous for developing the algebraic solution to the general cubic equation.
    - He provided the first Italian translations of works by the ancient Greek mathematicians Archimedes and Euclid.
    - By studying the projectile motion of cannonballs, Tartaglia is considered the originator of the science of ballistics.
  + Gerolamo Cardan (1501 – 1576)
    - Gerolamo Cardan was the first European mathematician to make systematic use of negative numbers.
    - In his influential 1545 book Ars Magna, Cardano published methods for solving cubic and quartic equations.
    - Cardano also introduced binomial coefficients and the binomial theorem to Europe.
    - Cardan acknowledged the existence of imaginary numbers..
    - Cardano's Liber de ludo aleae (The Book on Games of Chance), written around 1564 and published posthumously, is considered the first systematic explanation of probability theory.
* **1600AD- 1700AD**
  + René Descartes (1596 – 1650)
    - French mathematician
    - Descartes is the Father of Analytical Geometry, which allows us to describe geometric shapes using algebra.
    - This was one of the prerequisites, which allowed Newton and Leibnitz to invent calculus a few decades later.
    - He is credited with the first use of superscripts for powers or exponents, and the cartesian coordinate system is named after him.
  + Pierre De Fermat (1607 – 1665)
    - French mathematician
    - He was an early pioneer of calculus, as well as working in number theory, probability, geometry and optics.
    - Fermat’s Last Theorem -One of the most famous unsolved problems in mathematics until it was finally proven in 1994.
  + Gottfried Wilhelm Leibniz (1646 – 1716)
    - German mathematician
    - He was one of the inventors of calculus, and created some of the first mechanical calculators.
* **1700AD – 1800AD**
  + Leonhard Euler (1707 – 1783)
    - Swiss mathematician.
    - Graph Theory and Topology - Euler's solution of the Königsberg bridge problem is considered to be the first theorem of graph theory. In addition, his recognition that the key information was the number of bridges and the list of their presaged the development of topology.
    - Complex Analysis -  Euler's formula and Euler's identity.
    - Number Theory : A lot of his early work on number theory was based on the works of Pierre de Fermat, and developed some of Fermat's ideas.
    - Euler proved Newton's identities, Fermat's little theorem, Fermat's theorem on sums of two squares, and made distinct contributions to the Lagrange's four-square theorem.
    - He integrated Leibniz's differential calculus with Newton's Method of Fluxions, and developed tools that made it easier to apply calculus to physical problems.
  + Johann Lambert (1728 – 1777)
    - Swiss mathematician
    - He was the first to prove that *π* is an irrational number.
    - Geometry and Cartography : He created map projections, and foreshadowed the discovery of non-Euclidean spaces.
  + Joseph-Louis Lagrange (1736 – 1813)
    - Italian and naturalized French mathematician.
    - **Calculus of Variations** : Lagrange was a founder of this field, deriving Euler-Lagrange equations for finding extrema of functionals and extending the method to incorporate constraints with Lagrange multipliers.
    - **Taylor Series**: He developed a novel approach to Taylor series, including the Lagrange remainder.
    - **Interpolation**: He developed a new method for polynomial interpolation, known as the Lagrangian polynomial.
    - **Lagrange's Theorem: This** fundamental theorem of group theory states that a subgroup's order must divide the order of the group.
    - **Four-Square Theorem**: He proved that every natural number can be expressed as the sum of four squares.
  + Carl Friedrich Gauss (1777 – 1855)
* German Mathematician
* Algebra & Number Theory :
  + - Gauss proved the fundamental theorem of algebra.
    - Introduced **modular arithmetic** with the congruence symbol ≡.
    - Proved **Fermat’s Last Theorem for n = 3 and n = 5** (used Eisenstein integers for n=3)
    - Introduced the ring **Z[i]**.
* Analysis :
  + - One of Gauss's first discoveries was the notion of the arithmetic-geometric mean (AGM) of two positive real numbers.
    - Introduced **Gauss continued fractions**.
    - Understood **Cauchy’s theorem** and **residues** before Cauchy published.

### Numerical Analysis

* + - **Gaussian Quadrature (1816)** - Efficient numerical integration technique.
    - **Gauss-Seidel Method** - Iterative approach for solving linear systems.
    - **Discrete Fourier Transform (1805) -** Algorithm for trigonometric interpolation (precursor to FFT).

### Topology

* + - Gauss was also an early pioneer of topology.
    - The first proof of the fundamental theorem of algebra in 1799 contained an essentially topological argument; fifty years later, he further developed the topological argument in his fourth proof of this theorem
    - Developed **Gauss codes** for classifying self-intersecting curves.
  + Augustin Louis Cauchy (1789 –1857)
* French [mathematician](https://en.wikipedia.org/wiki/Mathematician" \o "Mathematician)
* [Cauchy Integral Theorem](https://www.google.com/search?sca_esv=e4298489537a3a9f&cs=0&sxsrf=AE3TifNzFhCnJHoMTNBxuHMqzTxnmVZvcw%3A1756614153820&q=Cauchy+Integral+Theorem&sa=X&ved=2ahUKEwiF_5LVmbSPAxXxzTgGHSE4EuEQxccNegQIQhAB&mstk=AUtExfD4mkUYqaRx2JTLKCn3Gm9M5b7xMBp8gzngmkY58w6kBqF43BI-S_xALzQ4rWxTUN9iDfAe7Hp9fG0sMGzB2C9BzYbaVrMAYcKOu53uwepUDrRCjymPA1kD2EpJetLL3ieNuC8jluSdkbFngz5BjAZgU74r6dPdQ9RYZXTaUuTTZZi5E9K9ofw8848a_5TBrOzSTYcWbJDVZGIr_M3OxGDS2SYPEwm12mhPXrpe-FBtNjzU6msZWBz5ZIbYBQcp5Fe6MGZ5I5Kiv_Ox0zrVCAOHZ-hj0fLj3T12jAkuGiwVJg&csui=3" \t "_blank):
* Convergence Tests: His work included the development of tests for the convergence of infinite series, such as the Cauchy condensation test.
* [Taylor's Theorem](https://www.google.com/search?sca_esv=e4298489537a3a9f&cs=0&sxsrf=AE3TifNzFhCnJHoMTNBxuHMqzTxnmVZvcw%3A1756614153820&q=Taylor%27s+Theorem&sa=X&ved=2ahUKEwiF_5LVmbSPAxXxzTgGHSE4EuEQxccNegQIFxAB&mstk=AUtExfD4mkUYqaRx2JTLKCn3Gm9M5b7xMBp8gzngmkY58w6kBqF43BI-S_xALzQ4rWxTUN9iDfAe7Hp9fG0sMGzB2C9BzYbaVrMAYcKOu53uwepUDrRCjymPA1kD2EpJetLL3ieNuC8jluSdkbFngz5BjAZgU74r6dPdQ9RYZXTaUuTTZZi5E9K9ofw8848a_5TBrOzSTYcWbJDVZGIr_M3OxGDS2SYPEwm12mhPXrpe-FBtNjzU6msZWBz5ZIbYBQcp5Fe6MGZ5I5Kiv_Ox0zrVCAOHZ-hj0fLj3T12jAkuGiwVJg&csui=3" \t "_blank): He was the first to prove Taylor's theorem and to establish a definitive form for its remainder.
* [Complex Functions](https://www.google.com/search?sca_esv=e4298489537a3a9f&cs=0&sxsrf=AE3TifNzFhCnJHoMTNBxuHMqzTxnmVZvcw%3A1756614153820&q=Complex+Functions&sa=X&ved=2ahUKEwiF_5LVmbSPAxXxzTgGHSE4EuEQxccNegQIMRAB&mstk=AUtExfD4mkUYqaRx2JTLKCn3Gm9M5b7xMBp8gzngmkY58w6kBqF43BI-S_xALzQ4rWxTUN9iDfAe7Hp9fG0sMGzB2C9BzYbaVrMAYcKOu53uwepUDrRCjymPA1kD2EpJetLL3ieNuC8jluSdkbFngz5BjAZgU74r6dPdQ9RYZXTaUuTTZZi5E9K9ofw8848a_5TBrOzSTYcWbJDVZGIr_M3OxGDS2SYPEwm12mhPXrpe-FBtNjzU6msZWBz5ZIbYBQcp5Fe6MGZ5I5Kiv_Ox0zrVCAOHZ-hj0fLj3T12jAkuGiwVJg&csui=3" \t "_blank): He introduced fundamental theorems of complex analysis, including the Cauchy-Riemann equations and the Residue Theorem.
  + Évariste Galois (1811 – 1832)
* The French mathematician
* Group theory and Galois theory : Galois proved that there is no general solution for polynomial equations of degree five or higher simultaneously with Niels Abel.
  + Arthur Cayley (1821 – 1895)
* British mathematician
* Group Theory : He first proposed the modern definition of a “group”, and generalised them to encompass many more applications in mathematics. Cayley also developed matrix algebra, and worked on higher-dimensional geometry.
  + Pafnuty Chebyshev (1821 – 1964)
* Russian mathematician
* Chebyshev Inequality : The Chebyshev inequality is used to prove the weak law of large numbers.
* Building on the work of Bernhard Riemann, the prime number theorem was proved by Chebyshev in 1896.
* Chebyshev Polynomials and the Chebyshev Bias : The difference between the number of primes that are congruent to 3 (modulo 4) and 1 (modulo 4).
* Chebyshev was the first person to think systematically in terms of random variables and their moments and expectations**.**
  + Carl Jacobi (1804 –1851 )
* German Mathematician
* Elliptic Functions : Jacobi was a founder of elliptic function theory.
* Linear Algebra: Jacobi made significant contributions to linear algebra and matrix theory, including the development of the Jacobi identity for Lie brackets. .
* The Jacobian: He introduced the functional determinant, known as the Jacobian, which is essential for the change of variables in multi-variable integrals and has wide applications in applied mathematics and probability theory.
  + Bernhard Riemann (1826 – 1866)
* German Mathematician
* Riemannian Geometry: He developed a way to describe curved spaces and manifolds and it was crucial for Einstein's formulation of the theory of general relativity.
* Riemann Hypothesis : In paper on the Riemann zeta function, he made conjectures about its properties, including the famous Riemann hypothesis. This remains one of the most important unsolved problems in mathematics, concerning the distribution of prime numbers.
* Riemann Integral : He provided the first rigid definition of the integral, known as the Riemann integral, a fundamental concept in real analysis and calculus.
* Riemann Surfaces : In complex analysis, he introduced Riemann surfaces, a geometric approach for the study of complex functions.
  + David Hilbert ( 1862 – 1943 )
* German Mathematician
* Foundations of Geometry - He established a set of 21 axioms that served as a more comprehensive and logically consistent foundation for geometry.
* Hilbert’s Problems : Hilbert presented a list of 23 unsolved problems, known as Hilbert’s Problems. These Problems became a guiding framework for mathematical research in the 20th century, fostering collaboration and innovation.
* Hilbert Space and Functional Analysis: A Hilbert space is an infinite-dimensional generalization of Euclidean space that provides a framework for studying functions and operators.
  + Henri Lebesgue (1875 – 1941)
* French mathematician
* Theory of Measure : Lebesgue formulated the Theory of Measure in 1901 and the following year he gave the definition of the Lebesgue integral that generalises the notion of the Riemann integral.
* Lebesgue Integration : Unlike the Riemann integral, which divides the domain into vertical strips, Lebesgue's approach divides the range of the function
* Overcoming Riemann's Limitations:This new method was crucial for integrating functions that are highly discontinuous, which Riemann's integral struggled with.
* Foundational for Modern Analysis:By developing measure theory, Lebesgue created the essential tools needed to analyze a broader class of functions, leading to major advances in fields such as Probability Theory, Fourier Analysis and Partial Differential Equations.
* **1800AD – 1900AD**
  + Sir Andrew Wiles (Born 1953)
* The British mathematician
* Best known for proving Fermat’s Last Theorem, which, until then, was one of the most famous unsolved problems in mathematics.
  + Claude Shannon (1916 – 2001)
* American mathematician
* Father of Information Theory.
  + Shiing-Shen Chern (1911 – 2004)
* Chinese-American mathematician
* He is the father of Modern Differential Geometry.
* His work on geometry, topology, and knot theory even has applications in string theory and quantum mechanics.