

MATHEMATICS: PATTERN & CALCULATION

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START HERE

SURVEY THE TOPIC

- Courant and Robbins, *What Is Mathematics? an elementary approach*, QA37.2.C69 1996 (Classic)
- The Encyclopedia Britannica*, Reference-AE5.E363 1997 (Comprehensive articles on all topics presented here)
- Hardy, *A Mathematician's Apology*, QA7.H3 1992 (Classic personal account of mathematical work)
- Kline, *Mathematics In Western Culture*, QA21.K52
- Kurtz, *Handbook of Applied Mathematics for Engineers and Scientists*, TA332.K87 1991
- The Math Archives, <http://archives.math.utk.edu/>
- The Math Pages, <http://www.seanet.com/~ksbrown/index.htm> (Comprehensive)
- Zwillinger, *The CRC Standard Mathematical Tables*, 30th ed., QA47.M315 1996

CLARIFY TERMS

- Cambridge Maths Thesaurus, <http://thesaurus.maths.org/> (Searchable, with convenient cross-reference links)
- Cut the Knot Glossary of Mathematical Terms, <http://www.cut-the-knot.com/glossary/atop.html>
- Earliest Known Uses of Some of the Words of Mathematics, <http://members.aol.com/jeff570/mathword.html>

FIND MORE

EXPERTS

- American Mathematical Society, <http://www.ams.org/> (Comprehensive)
- European Mathematical Information Service, <http://www.emis.ams.org/>
- Google Mathematics & Computer Science Libraries, http://directory.google.com/Top/Reference/Libraries/Subject_Specific/Science/Mathematics_and_Computer_Science/
- Mathematical Association of America, <http://www.maa.org/>
- National Council of Teachers of Mathematics, <http://www.nctm.org/>
- Society for Industrial and Applied Mathematics, <http://www.siam.org/>

FIND BOOKS, MAGAZINE ARTICLES & INTERNET SITES

- Bibliographies on Mathematics, <http://iinwww.ira.uka.de/bibliography/Math/>
- The Euler Project, <http://www.emis.de/projects/EULER/> (European-focused search engine)
- Mathematics WWW Virtual Library, <http://euclid.math.fsu.edu/Science/math.html> (Florida State University directory)
- Mathematics on the Web, <http://www.ams.org/mathweb/mi-mathinfo07.html> (American Mathematical Society directory)
- MathSciNet, <http://www.ams.org/mathscinet> (Periodical index)
- MathSearch, <http://www.maths.usyd.edu.au:8000/MathSearch.html> (University of Sydney search engine)
- Reader's Catalog suggested books in Mathematics, <http://shop.barnesandnoble.com/rdrscat/rcTopicsDrill.asp?userid=1LPMBCQ1NR&msscoid=744WSFNT3P3W9H5EQBCDD2KBT3R4W1E&rcTopicCode=7000.0500>
- Resources in Mathematics, <http://pantheon.yale.edu/%7Edstern/math.html> (Physics-Astronomy-Math Special Libraries Assoc.)
- Sci Net Mathematics directory, <http://www.scinet.cc/cgi-bin/search/hyperseek.cgi?search=CAT&Category=Math>

NEWS SOURCES

Nature, <http://www.nature.com/nature/>
New Scientist, <http://www.newscientist.com/> (Well-written UK weekly)
Notices of the American Mathematical Society, <http://www.ams.org/notices/>
Science, <http://www.sciencemag.org/>

MATHEMATICS A - Z:

ALGEBRA is a generalization of arithmetic in which letters representing numbers--VARIABLES--are combined in equations according to the basic OPERATIONS of arithmetic--addition, subtraction, multiplication and division. LINEAR EQUATIONS are a special category of equations that have no terms that are products or powers of the variables. The comparative study of algebraic systems is known as UNIVERSAL ALGEBRA. Work in CATEGORIES attempts to formalize of the domains and functions of the different areas of mathematical discourse.

Abstract Algebra On Line, <http://www.math.niu.edu/~beachy/aaol>
Algebra Online, <http://www.algebra-online.com/>
Johnson, *How To Solve Word Problems*, QA157.J7 1994
Meserve, *Fundamental Concepts of Algebra*, QA154.2.M47 1982
van der Waerden, *A History of Algebra from al-Khwarizmi to Emmy Noether*, 1985

ANALYSIS in mathematics studies sets of numbers, points and functions that are infinitely large, small, near and divisible by means of the FUNCTION--a rule or equation that identifies for each independent value a corresponding dependent value. The rate at which the dependent value changes relative to the independent value is the DERIVATIVE. REAL ANALYSIS is comprised of DIFFERENTIAL CALCULUS--i.e. "calculus"--which studies the difference between consecutive values of continuously varying quantities and their rate of change; and INTEGRAL CALCULUS, which studies the sums of infinitesimal functions of the variable. VECTOR ANALYSIS applies real analysis to quantities having direction and magnitude. COMPLEX ANALYSIS studies function which include variables that are complex (include the square root of negative one). DIFFERENTIAL EQUATIONS are a type of equation in which the function is related to its derivative, which is useful for describing the behavior of rates of change. For example, differential equations describing behavior within a mathematical space--a manifold--can describe the occurrence of random behavior within a deterministic system: "chaos." FOURIER ANALYSIS studies functions which include variable that are trigonometric (include sine, cosine) The CALCULUS OF VARIATIONS studies the length and path of arcs connecting two points. FUNCTIONAL ANALYSIS studies sequences of functions with the techniques used to describe numbers and points.

Arnol, *Catastrophe Theory*, 3rd, QA614.58.A7613 1992
Berlinski, *A Tour of the Calculus*, QA303.B488 1995
Finite Mathematics and Applied Calculus Resource Page, <http://147.4.150.5/~matscw/RealWorld/index.html>
Gilmore, *Catastrophe Theory for Scientists*, QC20.C36G55 1993
Google Chaos & Fractals directory, http://directory.google.com/Top/Science/Math/Chaos_and_Fractals/
Kammingo, "What Is This Thing Called Chaos?" *New Left Review*, no. 181, 1990
Mandelbrot, *The Fractal Geometry of Nature*, QA447.M357 1982 (Reviewed in *Scientific American*, March 1982, p. 34)
Mandelbrot Explorer, <http://www.softlab.ece.ntua.gr/miscellaneous/mandel/mandel.html> (National Technical University of Athens)
Sawyer, *What Is Calculus About?*, QA303.S2

ARITHMETIC includes elementary number systems, measurement and the art of computation with addition, subtraction, multiplication, division, powers, roots and logarithms.

Poyla, *How To Solve It*, QA36.P76h 1985
Seiter, *Everyday Math for Dummies*, QA36.S45 1995
Serre, *A Course In Arithmetic*, QA243.S4713

COMBINATORICS studies arrangements, operations, and selections within a finite system. One of the basic problems is to determine the number of possible configurations, e.g., graphs, designs, arrays. COMBINATIONAL GEOMETRY studies relations among members of finite systems of geometric figures subject to various conditions and restrictions.

Balakrishnan, *Schaum's Outline of Combinatorics*, QA164.B35 1995
The Electronic Journal of Combinatorics, <http://www.combinatorics.org/>
Erich's Combinatorial Geometry Page, <http://www.stetson.edu/~efriedma/comb.html>

COMPUTER SCIENCE. The development of software and hardware has been and continues to be informed by a combination of many branches of mathematics, such as information theory, performance studies of systems and the analysis of ALGORITHMS--systematic procedures for determining answers to mathematical problems. to

Goldstein, *Computers from Pascal to Von Neumann*, TK885.A5G64
Google Computer Science directory, http://directory.google.com/Top/Computers/Computer_Science/
The Virtual Library of Computing, <http://www.vlib.org/Computing.html>
Knuth, *Selected Papers on Computer Science*, QA76.6.K537 1996

Wiener, *Cybernetics*, 2nd, Q175.W6516 1961

Wiener, *The Human Use of Human Beings: cybernetics and society*, Q310.W5 1988

GAME THEORY analyzes situations in which there is an interplay between parties that may have similar, opposed, or mixed interests. In a typical game, players, who each have their own goals, try to outsmart one another by anticipating each other's decisions; the game is finally resolved as a consequence of the players' decisions. A solution to a game prescribes the decisions the players should make and describes the game's appropriate outcome.

Al Roth's Game Theory and Experimental Economics Page, <http://www.economics.harvard.edu/~aroth/alroth.html>

Davis, *Game Theory: a nontechnical introduction*, QA269.D38 1997

Eigen and Winkler, *Laws of the Game*, Q175.E713 1993

Game Theory: an Introductory Sketch, <http://william-king.www.drexel.edu/top/eco/game/game.html>

Kahneman and Tversky, "The Psychology of Preferences," *Scientific American*, January 1982

Smith, "The Evolution of Behavior," *Scientific American*, September 1978

Williams, *The Compleat Strategyst: being a primer on the theory of games of strategy*, QA270.W5 1986

GEOMETRY studies the properties of space and of objects in space. EUCLIDEAN geometry studies two- and three-dimensional figures by means of a deductive system in which assertions about the properties of figures--theorems--are derived sequentially from previous theorems, which are ultimately derived from a set of axioms. ANALYTIC geometry studies points in space, especially curves, in the language of numerical coordinates. In ALGEBRAIC geometry, figures are studied in the language of algebra. Other kinds of geometries derive from beginning with sets of axioms different from Euclid's: the HYPERBOLIC, in which "parallel" lines diverge; ELIPTIC, in which they meet. RIEMANNIAN geometry provides the language of the general theory of relativity. PROJECTIVE geometry studies the representation or mapping of a line or plane onto another line or plane, from a point not lying in either. DIFFERENTIAL geometry studies curves and surfaces in space in the language of calculus. TOPOLOGY studies the properties of geometric figures that remain unchanged even when under distortion.

Chinn and Steenrod, *First Concepts in Topology*, QA611.C42

Coxeter, *Projective Geometry*, 2nd, QA471.C67 1987

Courant and Robbins, *What Is Mathematics? an elementary approach*, QA37.2.C69 1996 (See Chapter 5's surveys topology)

The Geometry Center, <http://www.geom.umn.edu/>

Heath, *The Thirteen Books of Euclid's Elements*, 2nd rev., QA31.E875 1956 vols 1-2 (Standard English edition)

Heyting, *Axiomatic Projective Geometry*, QA554.H48

Kelley, *General Topology*, QA5611.K4 1975

Kinsey, *Topology of Surfaces*, QA611.K47 1993

Osserman, *Survey of Minimal Surfaces*, QA644.O87 1986

Stillwell, *Geometry of Surfaces*, QA645.S75 1992

Topology Atlas, <http://at.yorku.ca/topology/> (Don't miss the "Ask A Topologist" feature)

HISTORIES OF MATHEMATICS

Boyer, *A History of Mathematics*, QA21.B767 1989

British Society for the History of Mathematics, <http://www.dcs.warwick.ac.uk/bshm/resources.html>

Dilke, *Mathematics and Measurement*, QA22.D55 1988

Dorrie, *One Hundred Great Problems of Elementary Mathematics*, QA43.D613 1965

Eves, *An Introduction to the History of Mathematics*, 5th ed., QA21.E8

Ewald, *From Kant to Hilbert: readings in the foundations of mathematics*, QA8.6.F77 1996

Gray, *Ideas of Space: Euclidian, Non-Euclidean and Relativistic*, 1979

Kline, *Mathematical Thought from Ancient to Modern Times*, QA21.K516 1990 vols 1-2

Ronan and Needham, *The Shorter Science and Civilization in China: vol 3: Mathematics*, Q127.C5 v. 3

Wilkins, *The History of Mathematics*, <http://www.maths.tcd.ie/pub/HistMath/>

MATHEMATICS & THE ARTS

Emmer, *The Visual Mind: art and mathematics*, N72.M3V58 1993

Math Archives resources on Mathematics and Art and Music, <http://archives.math.utk.edu/topics/artMusic.html>

Ozdural, "Omar Khayyam, Mathematicians and Conversazioni with Artisans," *JSAH*, March 1995

Rothstein, *Emblems of Mind: the inner life of music and mathematics*, ML3800.R62 1995

Scientific American magazine features each month an article titled "Mathematical Recreations."

AESTHETICS OF ABSTRACTION: Dabrowski, *Contrasts of Form: geometric abstract art 1910-1980*, 1985; Harrison and

Wood, *Art In Theory 1900-1990*, Reference-N6450.A7167 1992 (See the sections "Abstraction and Form," and

"Objecthood and Reductivism"); Krauss, "LeWitt in Progress," *October*, no. 6, 1978

COMPOSITIONAL SYSTEMS: Damisch, *The Origin of Perspective*, NC750.D3413 1994; Pedoe, *Geometry and the Visual*

Arts, QA445.P44 1983; Robison, "Optics and Mathematics in the Domed Churches of Guarino Guarini," *JSAH*,

December 1991; Wrightman, "The Imperial Fora of Rome: some design considerations," *JSAH*, March 1997

PROPORTIONAL SYSTEMS: Huntley, *Divine Proportion: study in mathematical beauty*, QA466.H85 1970; Kepes, *Module, Proportion, Symmetry, Rhythm*, N76.K4; Necipoglu, *The Topkapi Scroll: geometry and ornament in Islamic architecture*, NA2706.A783N45 1995 (Chapter 5 is essential); Panofsky, "The History of the Theory of Human Proportions," *Meaning in the Visual Arts*, N7445.2.P35 1982; Rowe, *Mathematics of the Idea Villa*, NA7110.R68; Turner, *The Dictionary of Art*, Reference-N31.D5 1996 (Entries under "Architectural proportion" and "Human proportion"); Wittkower, *Architectural Principles in the Age of Humanism*, NA520.W5

NUMBER THEORY is concerned with the properties of numbers. Branches include the study of primes, the study of ALGEBRAIC numbers--complex numbers that are roots of polynomial equations with integer coefficients--and the opposite of algebraic numbers, TRANSCENDENTAL numbers.

Dantzig, *Number: the language of science*, QA9.D2 1954

Enzenberger, *The Number Devil*, PZ7.E72455Nu 1998 (Eminent German leftist intellectual's children's book on number theory)

Math Info-Structure, <http://pint4.ping.be/~ping6758/index.shtml>

Maor, *To Infinity and Beyond*, QA9.M316 1991 (Interesting cultural history)

Number Theory Web, <http://www.math.uga.edu/~ntheory/web.html> (University of Georgia)

Ribenboim, *Little Big Book of Primes*, QA246.R472 1991

Weil, *Basic Number Theory*, QA241.W33 1995

NUMERICAL ANALYSIS comprises three related activities: the study of a problem by the computation of numerical values that solve the mathematical equations (called mathematical models) describing the behaviour of some system, the development of methods (called numerical algorithms) for finding those values, and the analysis of the properties of those methods.

de Boer, "Numerical Analysis," *McGraw-Hill Encyclopedia of Science & Technology*, Reference-Q121.M3 1997

NA Net, <http://www.netlib.org/na-net/>

OPTIMIZATION is a technique for improving or increasing the value of some numerical quantity that in practice may take the form of temperature, air flow, speed, pay-off in a game, political appeal, destructive power, information, monetary profit, and the like. Also known as OPERATIONS RESEARCH/MANAGEMENT SCIENCE (OR/MS).

Institute of Operations Research and the Management Sciences (INFORMS), <http://www.informs.org/>

PROBABILITY is concerned with activities in which the outcome of a given trial cannot be predicted with certainty, although the collective results of a large number of trials display some regularity.

Ekeland, *The Broken Dice*, QA273.E4533 1993

Math Archive resources in Probability, <http://archives.math.utk.edu/topics/probability.html>

Pascal, "Correspondence with Fermat on the Theory of Probabilities," *The Great Books: Pascal*, AC1.G7 vol. 33

PSEUDOSCIENCE

Paulos, *Innumeracy: mathematical illiteracy and its consequences*, 1989

Paulos, *A Mathematician Reads the Newspaper*, 1995

Yahoo! Numerology links,

http://dir.yahoo.com/Society_and_Culture/Religion_and_Spirituality/Faiths_and_Practices/Divination/Numerology/

REPRESENTATIONS OF MATHEMATICS IN LITERATURE & MOVIES

Kasman, Mathematical Fiction, <http://math.cofc.edu/faculty/kasman/MATHFICT/default.html> (Extensive annotated bibliography)

Purman University Mathematical Quotation Server, <http://math.furman.edu/~mwoodard/mqs/mquot.html>

The Math in the Movies Page, <http://world.std.com/~reinhold/mathmovies.html>

FICTION: Abbott, *Flatland: a Romance of Many Dimensions*, QA699.A13 1994; Aubuern, *Proof*, 2000; Clarke, "The Nine Billion Names of God;" Carroll, *A Tangled Tale*, 1885; Gardner, *The Universe In a Handkerchief: the mathematical recreation of Lewis Carroll*, QA95.G3325 1996; Le Guin, *The Left Hand of Darkness*; Lem, *Microworlds*, 1984;

MOVIES: Peckinpah, *Straw Dogs*, 1971; Weill, *It's My Turn*, 1980 (Contains "the most erudite mathematical scene in a major motion picture"); *A Hill On The Dark Side of the Moon*, 1983 (bio of Sonia Kovalevskaya); Menéndez, *Stand and Deliver*, 1987; van Sant, *Good Will Hunting*, 1997; Aronofsky, *Pi*, 1998; Howard, *A Beautiful Mind*, 2002

SET THEORY concerns collections of definite, distinguishable objects of perception or thought conceived as a whole, especially as it permits the study of the infinite as a mathematical object. Work in formalizing the axioms and principles of set theory has rendered the field almost equivalent to the study of the foundations of all mathematics.

Frege and Gödel, *Two Fundamental Texts in Mathematical Logic*, QA9.V28

Kosko, *Fuzzy Thinking*, BC108.K59 1993

Kosko and Isaka, "Fuzzy Logic," *Scientific American*, July 1993

Set Theory Page, <http://www.cis.syr.edu/~sanchis/setory.html> (Syracuse University)

Set Theory Pages, http://www.math.ufl.edu/~jal/set_theory.html (University of Florida)

Stoll, *Set Theory and Logic*, QA248.S7985

STATISTICS is the science of collecting, analyzing, presenting, and interpreting data. DESCRIPTIVE statistics concerns methods of presentation of data, via tables, graphs and summaries.

Gonick and Smith, *The Cartoon Guide to Statistics*, QA276.12.G67 1993

Huff, *How To Lie With Statistics*, HQ29.H82 1993

Hyper Stat Online Textbook, <http://davidmlane.com/hyperstat/>

TRIGONOMETRY is the branch of mathematics concerned with specific functions of angles and their application to calculations in geometry.

Abbott, *Teach Yourself Trigonometry*, 1992

Barnard, "Trigonometry," *The Encyclopedia Britannica*, Reference-AE5.E363 1997 vol. 28

Claeys, *An Introduction to Trigonometry*, <http://www.ping.be/~ping1339/gonio.htm>

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