Mathematics and its Applications

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Abstract

This article briefly narrates the history of mathematics and explains the its applications. It describes the applications of mathematics in various fields of science and engineering,

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1. Introduction

Algebra evolved from the rules and operations of arithmetic, which begins, with the four operations: addition, subtraction, multiplication and division of numbers. Operations in algebra follow the same rules as those in arithmetic. Algebra uses variables, which are symbols that represent a number and expressions, which are Mathematical statements that use numbers, and or variables.

Abstract algebra is the subject area of Mathematics that studies algebraic structures, such as Groups, Rings, Fields, Modules, Vector Spaces, and Algebras. The phrase Abstract Algebra was coined at the turn of the 20th century to distinguish this area
from what was normally referred to as Algebra, the study of the rules for manipulating formulae and algebraic expressions involving unknowns and real or complex numbers, often now called elementary algebra. Two Mathematical subject areas that study the properties of algebraic structures viewed as a whole are Universal Algebra and Category Theory. Algebraic structures, together with the associated homomorphisms, form categories. Category theory is a powerful formalism for studying and comparing different algebraic structures.

2. History of mathematics:

The end of 19th and the beginning of the 20th century saw a tremendous shift in methodology of Mathematics. Abstract algebra emerged around the start of the 20th century, under the name Modern Algebra. Its study was part of the drive for more intellectual rigor in Mathematics. Initially, the assumptions in classical algebra, on which the whole of mathematics (and major parts of the natural sciences) depend, took the form of axiomatic systems. No longer satisfied with establishing properties of concrete objects, mathematicians started to turn their attention to general theory. Formal definitions of certain algebraic structures began to emerge in the 19th century. For example, results about various groups of permutations came to be seen as instances of general theorems that concern a general notion of an abstract group. Questions of structure and classification of various mathematical objects came to forefront. These processes were occurring throughout all of mathematics, but became especially pronounced in algebra. Formal definition through primitive operations and axioms were proposed for many basic algebraic structures, such as groups, rings and fields. Hence, such things as group theory and ring theory took their places in pure mathematics.

Universal algebra has enjoyed a particularly explosive growth in the last twenty years, and a student entering the subject now will find an incomprehensible amount of material to digest. One of the aims of universal algebra is to extract, whenever possible, the common elements of several different types of algebraic structures. In achieving this, one discovers general concepts, constructions and results, which not only generalize but also unify the known special situations, thus leading to an economy of presentation. Being at a higher level of abstraction, it can also be applied to entirely new situations, yielding significant information and giving rise to new directions. In the study of the properties common to all algebraic structures (such as groups, rings, etc.) and even some of the properties that distinguish one class of algebras from another, lattices enter in an essential and natural way. In particular, congruence lattices play an important role. The origin of the lattice concept can be traced back to Boole's analysis of thought and Dedekind's study of divisibility. Schroeder and Pierce were also pioneers at the end of the last century. The subject started to gain momentum in 1930's and was greatly promoted by Birkhoff's book Lattice Theory in1940's. Lattice theory entered the foreground of mathematical interest and its rate of development increased rapidly.

Logic is much like mathematics in this respect: the so-called "Laws" of logic depend on how we define what a proposition is. The Greek philosopher Aristotle founded a system of logic based on only two types of propositions: true and false. The English mathematician George Boole (1815-1864) sought to give symbolic form to Aristotle's system of logic.

Boolean algebras, essentially introduced by Boole in 1850's to codify the laws of thought, have been a popular topic of research since then. A major breakthrough was the duality of Boolean algebras and Boolean spaces as discovered by Stone in 1930's. Stone also proved that Boolean algebras and Boolean rings are essentially the same in the sense that one can convert via terms from one to the other. Since every Boolean algebra can be represented as a field of sets, the class of Boolean algebras is sometimes regarded as being rather uncomplicated. However, when one starts to look at basic questions concerning decidability, rigidity, direct products etc., they are associated with some of the most challenging results.

Algebra is a field of mathematics. Usually, students in high school or elementary will be the first ones who will experience this subject. Most of them will say that it is probably one of the hardest and complicated subjects there is. Well, anything that is connected to Mathematics could really be. When someone will say the word Algebra out loud, numbers and equations will immediately pop into one's mind. What they do not usually know is what and who and how Algebra started. A brief history of Algebra will be read in this article, to understand why and how and who started Algebra in the first place.

The Greeks first introduced Algebra in the third century and eventually it was also traced to the early Babylonians. The Babylonians were the ones who created formulas and equations that we still use to solve situations until today. Diophantus was eventually named Algebra's Father. In the 16th century, Rene Descartes was one of the names that were famous because of the book that he wrote entitled La Geometrie.

3.APPLICATIONS OF MATHEMATICS IN VARIOUS FIELDS

In our daily life,we use mathematics in various fields.This talk portraits the role of mathematics in all aspects of our daily life.we know that mathematics is applied directly or indirectly in our every day life.

Mathematics is used in every area, has its own functions and has many career options. Algebra is used in study of symmetry in Chemistry, Networking, Computer Science, Physics, and Cryptology. Calculus is significant in Biology, Chemistry, the motion of water (Hydrodynamics), Physics, Rocket Science, Engineering, option price modeling in Economics and Business models, molecular structure, etc.

Real-Life Applications of Mathematics

Algebra

Differential equations and Fourier analysis

Geometry

Probability and statistics

Numerical analysis

Operation research and optimization

Algebra

- Computer Science
- Cryptology (and the Protection of financial accounts with encrypted codes)
- Scheduling tasks on processors in a heterogeneous multiprocessor computing network
- Study of crystal symmetry in Chemistry (Group Theory)

Differential Equations (Ordinary and Partial) and Fourier Analysis

- Most of Physics and Engineering (esp. Electrical and Mechanical)
- Sound waves in air; linearized supersonic airflow
- Crystal growth
- Casting of materials
- Materials science
- Transport and disposition of chemicals through the body
- Modeling of airflow over airplane bodies
- Photographic development (Eastman Kodak)
- Waves in composite media
- Immuno-assay chemistry for developing new blood tests
- Radio interferometry
- Free mesons in nuclear physics
- Seismic wave propagation in the earth (earthquakes)
- Heat transfer
- Airflow over airplane bodies (aerodynamics)

Differential and Computational Geometry

- Computer aided design of mechanical parts and assemblies
- Terrain modeling
- Molecular beam epotaxy modeling (computational geometry)
- Color balance in a photographic system
- Optics for design of a reflector
- Cryptology
- Airflow patterns in the respiratory tract

Probability and Statistics

- Calculation of insurance risks and price of insurance
- Analysis of statistical data taken by a census
- Reliability and uncertainty of large scale physical simulations
- Speech recognition

- Signal processing
- Computer network design
- Tracking and searching for submarines
- Estimation of ocean currents (geostatistics)
- Paint stripping using lasers
- Onset and progression of cancer and pre-malignant cells
- Determining launch schedules to establish and maintain prescribed satellite constellations (also uses Monte Carlo methods)
- Radar track initiation
- Aircraft survivability and effectiveness
- Color sample acceptance tolerance correlation and prediction
- Determination of sample sizes for color acceptability evaluation (uses advanced statistical methods)
- Underwater acoustic signal processing
- Reliability analysis of complex systems
- Radio interferometry
- A shopkeeper keeps more stock of a particular type of item which has more sale. Here the concept of MODE applies. The average daily expenditure in a month of a family gives the concept of MEAN .if 15 people of different heights are standing height-wise, then the middleman's height is the MEDIAN height.

Numerical Analysis

- Estimation of ocean currents
- Modeling combustion flow in a coal power plant
- Airflow patterns in the respiratory tract (and diff. eqs.)
- Regional uptake of inhaled materials by respiratory tract
- Transport and disposition of chemicals through the body (and ODEs + PDEs)
- Molecular and cellular mechanisms
- Trajectory prescribed path control and optimal control problems
- Scientific programming
- Modeling of airflow over airplane bodies
- Electromagnetics analysis for detection by radar
- Design and analysis of control systems for aircraft

- Electromagnetics
- Large scale shock wave physics code development
- Curve fitting of tabular data

Operations Research and Optimization

- Network formulation of cut order planning problem
- Shade sorting of colored samples to an acceptable tolerance by hierarchical clustering
- Inventory control for factory parts
- Search for and tracking of submarines
- Motion of a space vehicle
- Aircraft survivability and effectiveness
- Interplanetary mission analysis
- Radio interferometry
- Scheduling tasks on processors in a heterogeneous multiprocessor computing network
- Microwave measurements analysis
- Coordinate measuring machine (optimization error modeling)
- Optics for design of a reflector
- Materials science
- Reliability and uncertainty of large scale physical simulations

CALCULUS

it is the study of change.

It includes limits,derivatives,integrals,infinite series

It helps us to find the area of figures,to know the acceleration of a car moving in a highway with uniform speed

Also the movement of an artificial satellite,ship etc.

GRAPH THEORY

It is the study of Graphs

To find the easy route that can be used by a sailor from one port to another and so many appliations like travelling-salesman problem, etc.

NUMBER THEORY

It is the branch of pure maths concerned with the properties of numbers.

It is used for creating codes for ATMs /credit cards

MECHANICS

It is concerned with the behaviour of physical bodies subject to forces or displacement

Ex,maximum distance a football can be kicked by a goal-keeper at an angle of 45

GEOMETRY

Study of shape,size,relative position, of figures with properties of Space.

In house building,to find floor area—it is needed for finding the area of carpet or number of tiles required.

TRIGONOMETRY

It is used to find the height of a tree,building,angle of elevation etc

BIOLOGY

In this,SYMMETRY is a general concept of studies in science.

We can see bilateral symmetry in fish and radial symmetry in sea Anemone.

MEDICINE

I t is used in reconstruction of the shape of a tumour from CAT SCANS,and other medical measurements,Protein-modelling etc.

FLUID MECHANICS

Fluid mechanics is the branch of physics that studies the mechanics of fluids (liquids,gases,plasmas) and the forces on them. Fluid mechanics has a wide range of applications, including for mechanical engineering,civil engineering,chemical engineering,geophysics,astrophysics and biology. Fluid mechanics can be divided into fluid statics, the study of fluids at rest; and fluid dynamics, the study of the effect of forces on fluid motion. It is a branch of mechanics, a subject which models matter without using the information that it is made out of atoms. Fluid mechanics, especially fluid dynamics, is an active field of research with many problems that are partly or wholly unsolved. Fluid mechanics can be mathematically complex, and can best be solved by numerical methods typically using computers.

Fluid flow is governed by complicated nonlinear systems of partial differential equations. In many situations of interest the flow spans a huge range of length scales, with the nonlinearity of the governing equations resulting in the transfer of energy from one length scale to another. Because of this complexity, the field of fluid mechanics has been the birth place of many important ideas in mathematics. It continues to stimulate work in areas such as partial differential equations, asymptotics and perturbation theory, computational methods, and nonlinear waves, including solitons, instability theory, chaos, and stochastic processes.

Research projects range from the development of simple models used to understand aspects of complicated physical processes, to the use of advanced theoretical and numerical methods.

The assumptions inherent to a fluid mechanical treatment of a physical system can be expressed in terms of mathematical equations. Fundamentally, every fluid mechanical system is assumed to obey:

Conservation of mass

Conservation of energy

Conservation of momentum

Mathematics is an important part of most branches of engineering. They need to have the skill of solving mathematical models and interpreting the practical inferences. They can do this with the help of a computer. It is really necessary to keep up the correct balance between logical solutions and intuition, practice and theory, and analysis and synthesis.

Mathematics in various university degrees

The students who ignore Mathematics at High School level may lose several job opportunities in future. Most of the university degrees need mathematics. Listed below are a few areas that include Mathematics.

- Tech Sciences like Networking, Computer Science, Software Development, etc
- Physical Sciences including Engineering, Physics, Chemistry, etc
- Social Sciences like Communications, Linguistics, Anthropology, Economics, Geography, Education, etc
- Medicine
- Life and Health Sciences including Pharmacy, Biology, Optometry, Psychology, Nursing, etc
- Actuarial Science used by insurance companies
- Business and Commerce

Mathematics in variety of career options

Mathematics is used in every area, has its own functions and has many career options. Algebra is used in study of symmetry in Chemistry, Networking, Computer Science, Physics, and Cryptology. Calculus is significant in Biology, Chemistry, the motion of water (Hydrodynamics), Physics, Rocket Science, Engineering, option price modeling in Economics and Business models, molecular structure, etc.

Significance of Mathematics in Engineering

Mathematics is considered to be the base of all sciences. It has application in almost all the fields of scientific as well as non-scientific study. Mathematics is applied in elementary level subjects like Chemistry, Physics, Biology, etc as well as in complex studies like genetic analysis, cryogenics, etc. Both Mathematics and Applied Mathematics have a significant role in the first two years of any engineering degree course. The main topics in the first year are statics and dynamics of a particle, integration, and differentiation. In the second year, the importance is on differential equations and linear algebra.

Engineering can be defined as a specialized branch of science which constantly monitors the changing needs of the world. It also deals with the designing and manufacturing of the products that could make life simpler, fast and efficient. From the definition itself it is clear that the application of mathematics becomes indispensable for engineering. It is impossible to engineer something with out the help of mathematics. Since the applications of mathematics in engineering are so vast and varied, it is not possible to summarize them.

The most important areas of Mathematics in Engineering are trigonometry, differential equations, geometry, and integral mathematics. The Civil Engineering depends greatly on the trigonometric and geometric logics. The Computer Science Engineering is largely dependent on numeric analysis, combinatorics, logic analysis, and algebra. Electrical Engineering entails a lot of critical analysis, crypto analysis, operation research and management. This branch of engineering heavily utilizes the mathematical principles, logic, formulae, and calculations.

Thus, it can be concluded that in order to be a good engineer one should be capable of handling mathematical problems efficiently

Optimization Problem

Very often we come across a situation where we have a couple of different choices. But we want to choose the best option that brings us maximum benefit while staying under some constraints. There is a branch of Algebra called "Linear Programming" that deals with finding the best possible solution to an optimization problem while staying within prescribed limitations / constraints. The real world problem can be represented mathematically through algebraic expressions called linear inequalities. A solution to these linear inequalities gives the optimum solution to the problem.

In the world of science and engineering,

- Einstein's Equation of General Relativity
- Maxwell's Equations
- Navier-Stokes Equations
- Fourier Transform
- Shannon's Entropy
- Pythagoras Theorem
- Google's PageRank
- Facebook's EdgeRank
- Eigenvalue and Eigenvalue equation in Linear Algebra

Conclusion: This article briefly narrates the history of mathematics and explains the its applications. It describes the applications of mathematics in various fields of science and engineering,

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