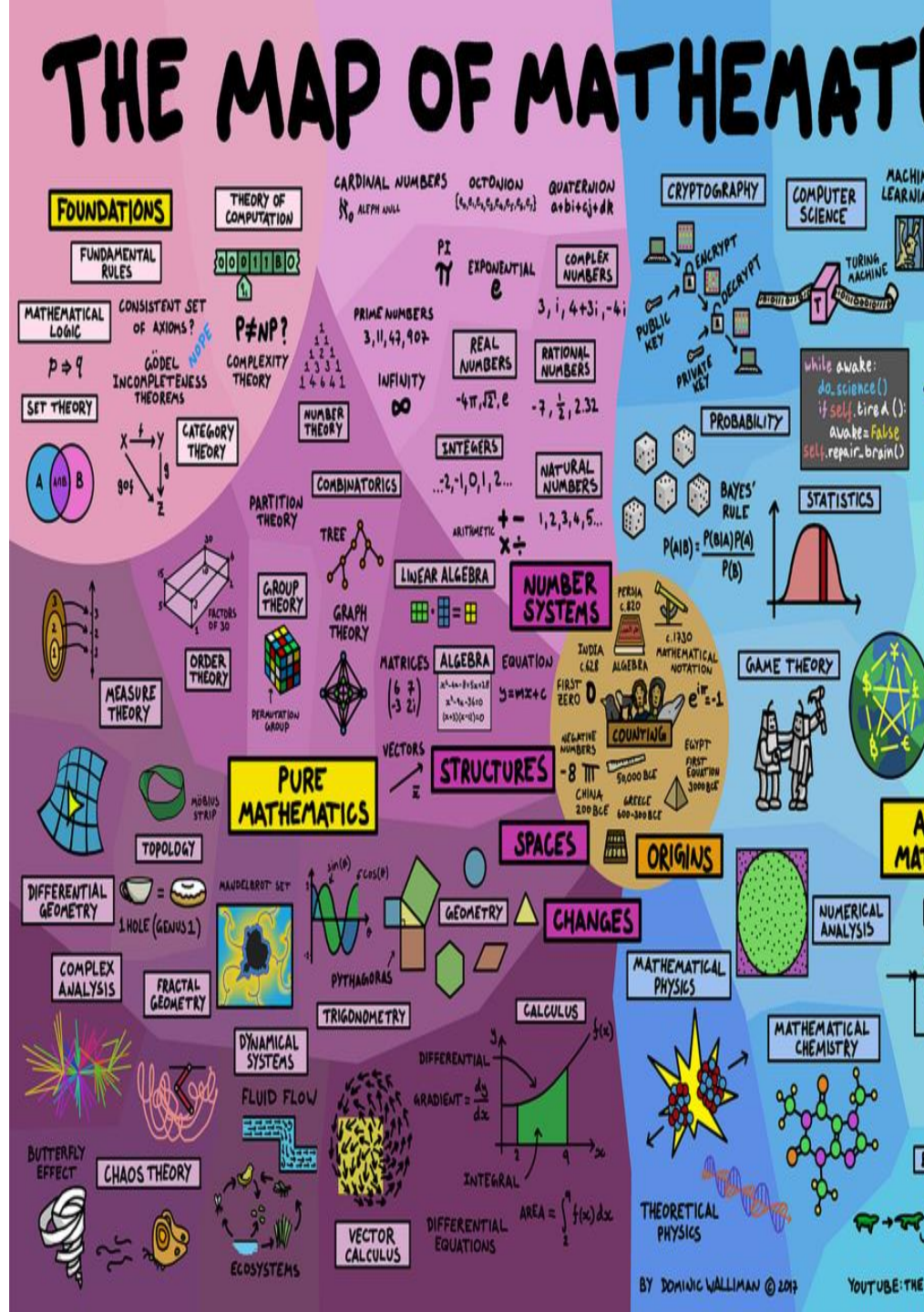


Calculus & Analytical Geometry
MATH- 101

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Why mathematics?

- Mathematics is the study of how to create, manipulate & understand abstract structures.
- We study math because it teaches us a way of thinking.
- It provides us with a method of solving a whole host of life's problems away from the classroom

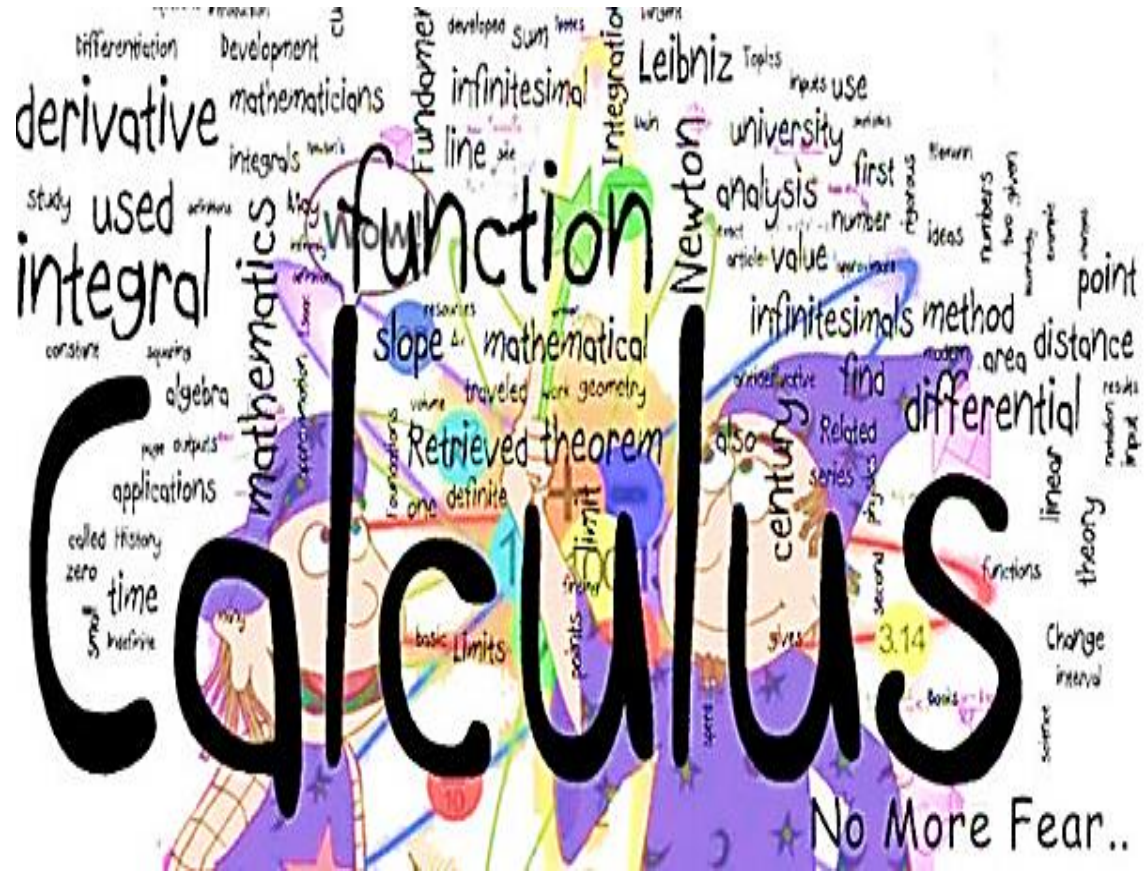


**What is
calculus??**



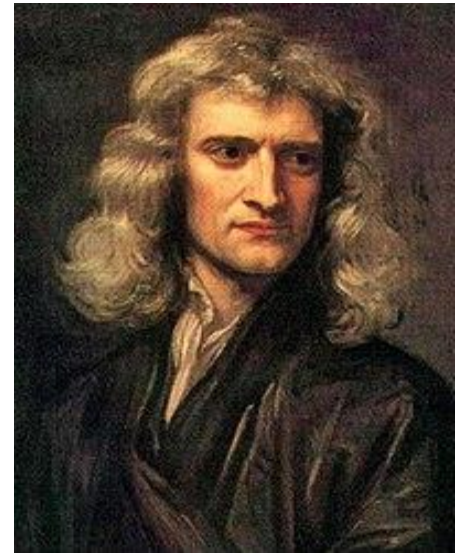
And the Answer is.....

- The word Calculus comes from Latin meaning "small stone", because it is like understanding something by looking at small pieces.
- Calculus is all about *changes*.
- It provides a framework for modeling systems in which there is change, and a way to deduce the predictions of such models.



History:

- ❖ Calculus was developed out of a need to understand continuously changing quantities.
- ❖ Newton, for example, was trying to understand the effect of gravity which causes falling objects to constantly accelerate.
- ❖ How can one, for example, determine the speed of a falling object at a frozen instant in time, such as its speed when it strikes the ground?
- ❖ No mathematician prior to Newton and Leibnitz's time could answer such a question.



Isaac Newton



Gottfried Wilhelm
Leibniz

Calculus is Divided into Two Categories

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graph TD; A[Calculus is Divided into Two Categories] --> B[Differential Calculus  
(Rate of Change)]; A --> C[Integral Calculus  
(Accumulation)]; B --> D[Fundamental Theorem of Calculus  
(Connects Differential and Integral Calculus)]; C --> D;
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Differential Calculus
(Rate of Change)

Integral Calculus
(Accumulation)

Fundamental Theorem of Calculus
(Connects Differential and Integral Calculus)

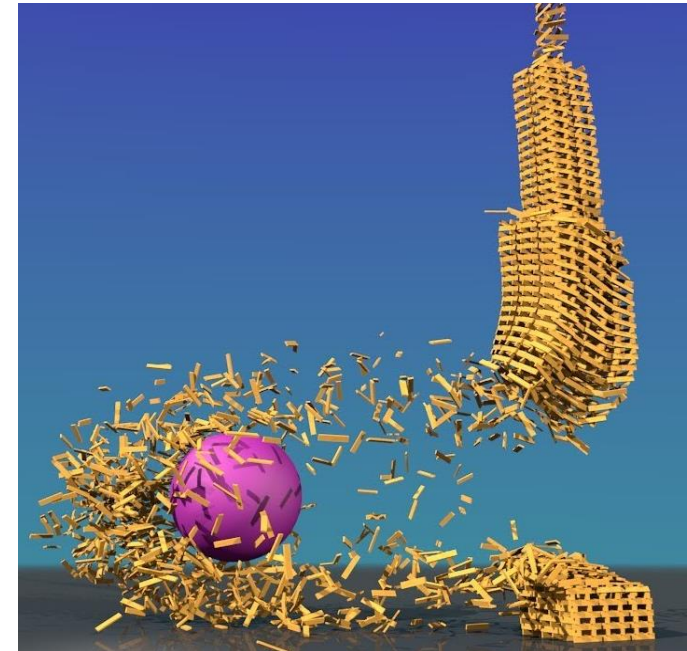
**Why do we
study Calculus?**



- Calculus is the branch of **mathematics** that deals with rates of change and **motion**.
- It grew out of a desire to understand various physical phenomena, such as the orbits of planets, and the effects of gravity.
- The immediate success of calculus in formulating physical laws and predicting their consequences led to development of a new **division** in mathematics called analysis, of which calculus remains a large part.
- Today, calculus is the essential language of science and **engineering**, providing the means by which physical laws are expressed in mathematical terms.
- As a scientific tool it is invaluable in the further analysis of physical laws, in predicting the behavior of electrical and mechanical systems governed by those laws, and in discovering new laws.

Applications of Calculus

- The usefulness of calculus is indicated by its widespread application.
- For example, it is used in the design of navigation systems, particle **accelerators**, and synchrotron **light** sources.
- It is used to predict rocket trajectories, and the orbits of communications satellites.
- Calculus is the mathematical tool used to test theories about the origins of the universe, the development of tornadoes and hurricanes, and **salt** fingering in the oceans.
- It has even found extensive application in business, where it is used, among other things, to optimize production.



**What is
Analytical
Geometry ??**



And the Answer is.....

- **Analytic geometry**, also called **coordinate geometry** or **Cartesian geometry** is a mathematical subject in which algebraic symbolism and methods are used to represent and solve problems in geometry.
- The importance of analytic geometry is that it establishes a correspondence between geometric curves and algebraic equations. This correspondence makes it possible to reformulate problems in geometry as equivalent problems in algebra, and vice versa; the methods of either subject can then be used to solve problems in the other.
- For example, computers create animations for display in games and films by manipulating algebraic equations.

Applications of Analytical Geometry

- Its most common application is in the representation of equations involving two or three variables as curves in two or three dimensions or surfaces in three dimensions. For example, the linear equation $ax + by + c = 0$ represents a straight line in the xy -plane, and the linear equation $ax + by + cz + d = 0$ represents a plane in space, where a , b , c , and d are constant numbers (coefficients).
- In this way a geometric problem can be translated into an algebraic problem and the methods of algebra brought to bear on its solution. Conversely, the solution of a problem in algebra, such as finding the roots of an equation or system of equations, can be estimated or sometimes given exactly by geometric means, e.g., plotting curves and surfaces and determining points of intersection.

Applications of Analytical Geometry

- Analytical Geometry has vast applications in our life both directly and indirectly.
- Analytic geometry is used in physics and engineering, and also in aviation, rocketry, space science, and spaceflight.
- It is used in medicine, power generation and in construction.
- It helps us to improve accuracy in medicine field for the betterment of the treatment.
- It is the foundation of most modern fields of geometry, including algebraic, differential, discrete and computational geometry.

Calculus and Analytical Geometry

- Analytic geometry has its greatest impact on mathematics via calculus.
- Without access to the power of analytic geometry, classical Greek mathematicians such as Archimedes solved special cases of the basic problems of calculus: finding tangents and extreme points (differential calculus) and arc lengths, areas, and volumes (integral calculus).
- The mathematicians were led back to these problems by the needs of astronomy, optics, navigation, warfare, and commerce. They naturally sought to use the power of algebra to define and analyze a growing range of curves.

Calculus and Analytical Geometry

- Newton and the German Gottfried Leibniz revolutionized mathematics at the end of the 17th century.
- Both men used coordinates to develop notations that expressed the ideas of calculus in full generality and led naturally to differentiation rules and the fundamental theorem of calculus (connecting differential and integral calculus).

Calculus & Analytical Geometry in the engineering field



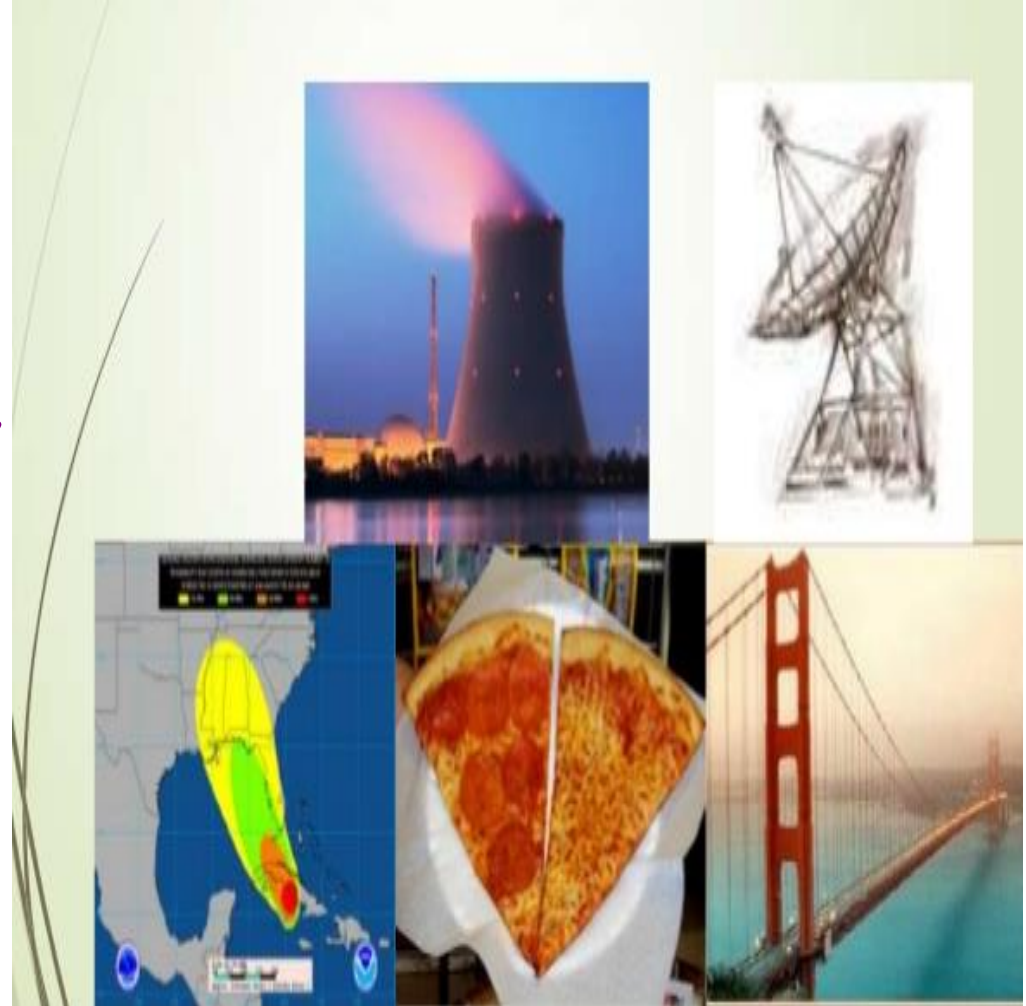
- ♣ Calculus was initially developed for better navigation system.
- ♣ Engineers use calculus for building skyscrapers, bridges.
- ♣ In robotics calculus is used how robotic parts will work on given command.
- ♣ Electrical and Computer engineers use calculus for system design.
- ♣ Calculus is used to improve safety of vehicles.



Calculus & Analytical Geometry is everywhere

The differentiation and integration have many real-world applications from sports to engineering to astronomy and space travel.

$$Life = \int_{birth}^{death} \frac{happiness}{time} \Delta time$$



Calculus & Analytical Geometry provides the foundation to physics, engineering, and many higher math courses. It is also important to chemistry, astronomy, economics and statistics. Medical schools and pharmacy schools use it as a screening tool.

I can go on and on but let me stop with this observation:

" today we can safely declare that there is no
branch of science which does not use

Calculus & Analytical Geometry."

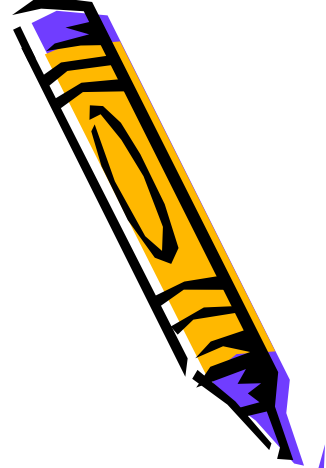
The real world applications need calculus. That is, perhaps, one reason why we demand calculus as a pre-requisite for all programs in different fields of studies.

Enjoy the course!



Course Description:

- ❖ The course reviews the concepts of basic calculus; including Limits, continuity, differentiation and integration.
- ❖ A brief account of three dimensional geometry and complex numbers is also included as pre-calculus review.
- ❖ Stress is laid on applications of differentiation and integration to practical/engineering problems.
- ❖ Convergence/divergence of the sequence and series are included towards the end of the syllabus.



Course Objectives:

Upon the successful completion of course students should develop understanding of the basic concepts of analytical geometry involving limits, continuity, differentiation and integration for solving the real world problems and analyzing the convergence/divergence of sequence and series.



Course Learning Outcomes (CLOs)



At the end of the course the students will be able to:

CLO1: Understand the concept of limit, continuity and derivative with its application to find extrema.

CLO2: Understand integration and use it to compute areas, volumes and arc length.

CLO3: Comprehend sequence, series and their convergence using miscellaneous tests.



Books



Text Books:

- Calculus and analytical Geometry (9th edition) by George B. Thomas, Jr. and Ross L. Finney
- Calculus (6th edition) by Swokowski, Olinick and Pence

Reference Book:

- Calculus (3rd edition) by Robert T. Smith and Ronald B. Minton

