FOSSEE Summer Fellowship Report

On

Mathematics using python

Submitted by

Aryan Singh
A.P.Shah Institute
of Technology
aryanam2000@gmail.com

Under the guidance of

Prof. Prabhu Ramachandran
Department of Aerospace Engineering
Indian Institute of Technology, Bombay

Mentors

Mr. Purusharth Saxena
Ms. Sharanya Achut

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Acknowledgment

I would like to express my sincere and deepest gratitude to FOSSEE, IIT Bombay for providing me this golden opportunity for learning and enhancing my knowledge in single variable calculus. I would like to thank my mentors **Ms. Sharanya Achut** and **Mr. Purusharth Saxena** for their time and valuable feedback. Their suggestions helped me a lot in improving my lecture notes and animations. The completion of my fellowship would not have been possible without the support and encouragement of my mentors and **Prof. Prabhu Ramachandran**. I would also like to extend my sincere thanks to my parents, family members, and friends for supporting me throughout this fellowship.

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Introduction

1.1 FOSSEE Animations and the Summer Fellowship

FOSSEE (Free/Libre and Open Source Software for Education) project promotes the use of FLOSS tools in academia and research. The FOSSEE project is part of the National Mission on Education through Information and Communication Technology (ICT), Ministry of Human Resource Development (MHRD), Government of India. FOSSEE animations is a library of community-curated animations on Science and Math. All animations are made using open-source software like Python and Manim.
Fellows had to create notes on mathematical topics supported by animations. Such work is significant because visualizations help in clearing concepts which would have otherwise been left ignored in study due to lack of proper explanations for each topic.
Manim, ffmpeg, LaTeX, Python and Git were used during the project.

1.2 Topic for the Fellowship – Introduction to calculus

Calculus is the branch of mathematics where we study change. Everything in and around you is constantly changing. Your age, your position, your phone's battery level. All these are measures of different quantities. But there is one thing that is common to them. They are changing. This change is what calculus tries to analyze. Calculus is studied in two parts. Derivative and integral. Derivative gives us the rate of change of a quantity with respect to another whereas integral gives us the accumulation of all the changes that occurred in any quantity in the interval of another quantity.

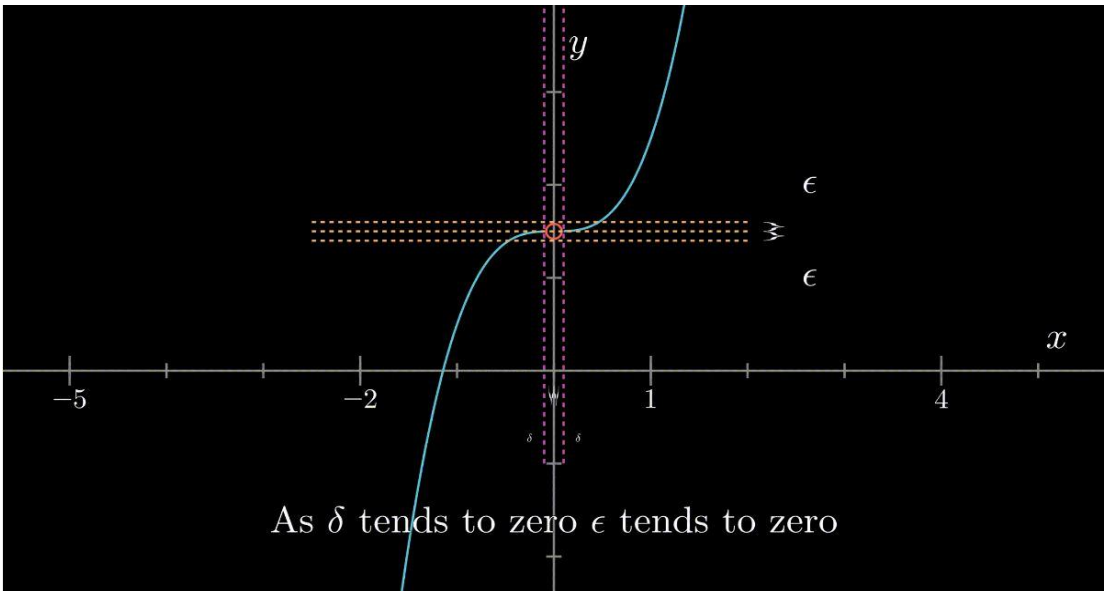
Applications of calculus include finding out speed, velocity, optimization, arc length, power series and Fourier series to name a few.

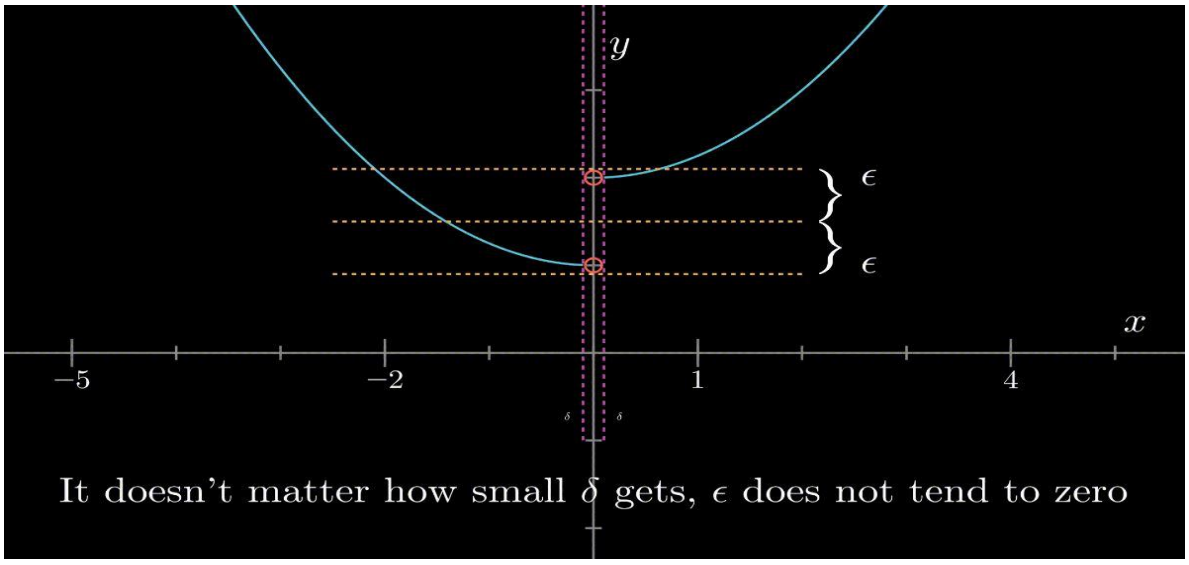
GitHub: https://github.com/FOSSEE/FSF-mathematics-python-code-archive/tree/master/FSF-2020/calculus/intro-to-calculus

When do limits exist?

Link for the subtopic

I begin the topic by highlighting the need for studying limits. Then I explain the meaning of basic terms related to limits, like neighborhood and tending of a variable towards a value. Then the formal epsilon-delta definition of limit is elucidated. Then the non-rigorous or the simpler definition of limit is covered. A total of 6 animations were created for this topic.



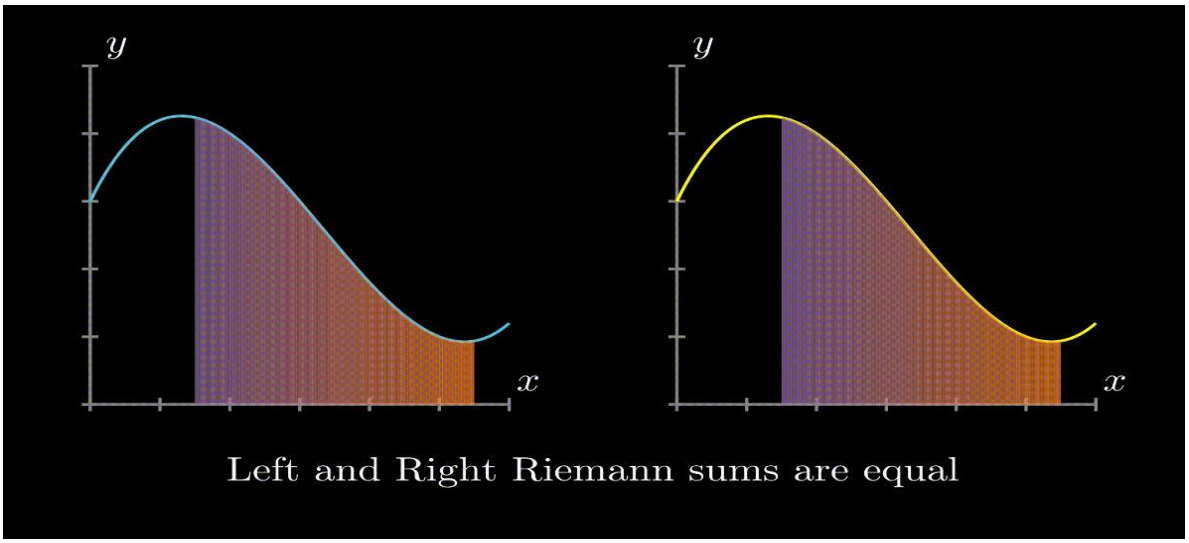


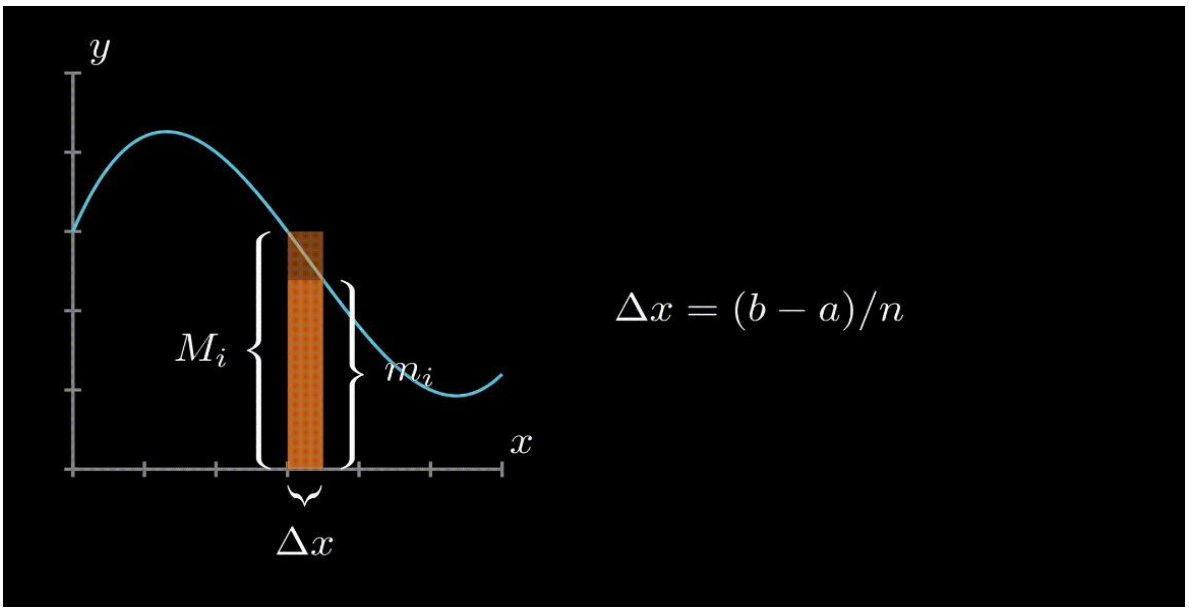
GitHub: https://github.com/FOSSEE/FSF-mathematics-python-code-archive/tree/master/FSF-2020/calculus/intro-to-calculus/limit

Infinite sums in a nutshell (Riemann Integrals)

Link for the subtopic

The fact that area is approximated using rectangular strips is talked about. The number of strips is then extended to infinity. The definition of the Riemann Integral explained. The idea of left Riemann sum and right Riemann sum is induced. The conditions for Riemann sums to form Riemann Integrals is explained. Moreover, the reader will learn how infinite sums relate to integration. The idea that a partition may not necessarily be of equal width is mentioned. A total of 5 animations were created for this topic.



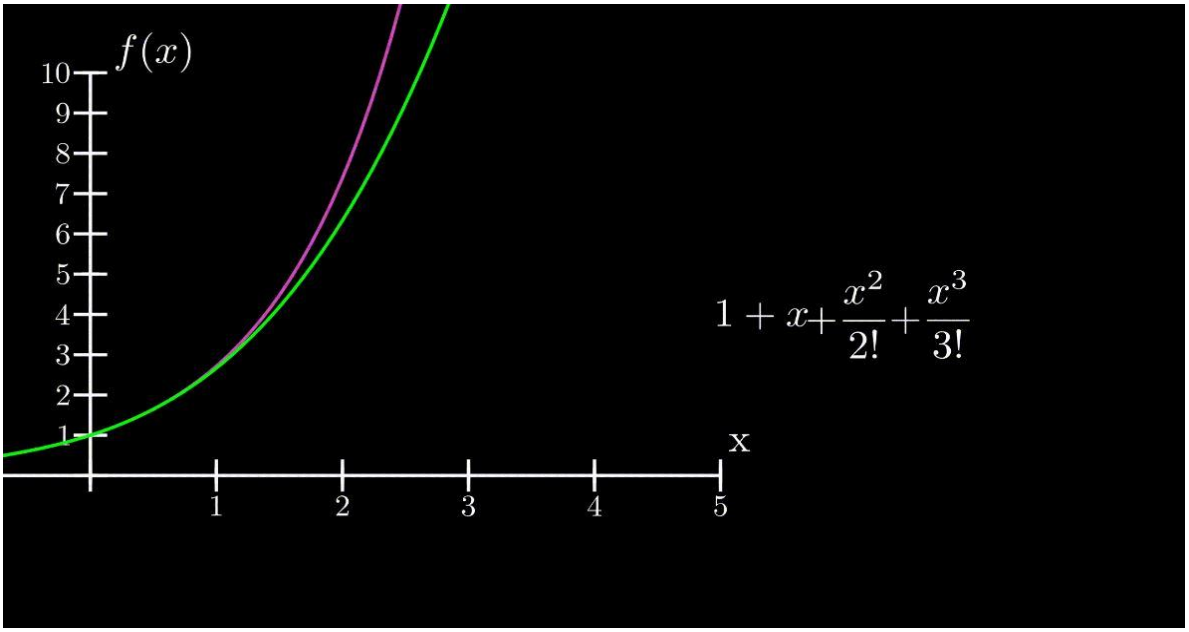


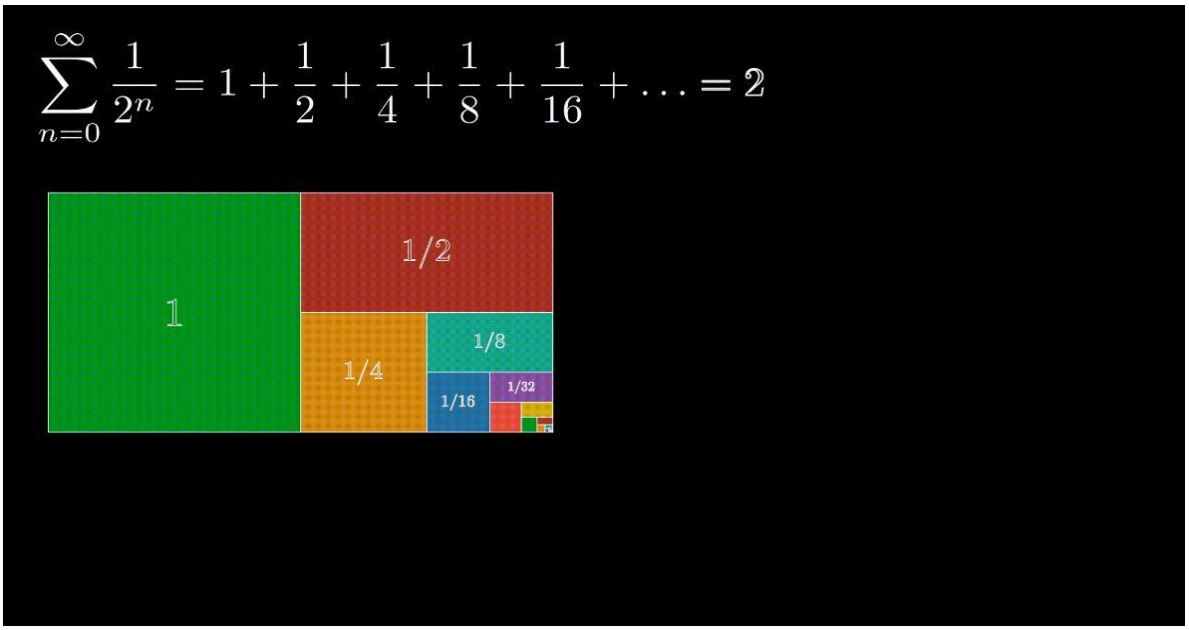
GitHub Link to the animations: https://github.com/FOSSEE/FSF-mathematics-python-code-archive/tree/master/FSF-2020/calculus/intro-to-calculus/riemannintegrals

Infinite sequences and series

Link for the subtopic

Three concepts are covered in this subtopic. Convergence, divergence and Taylor series which is an application of convergence. The explanations are done using relevant examples. The reason why we should study infinite series is explained. A total of 3 topics were created for this topic.



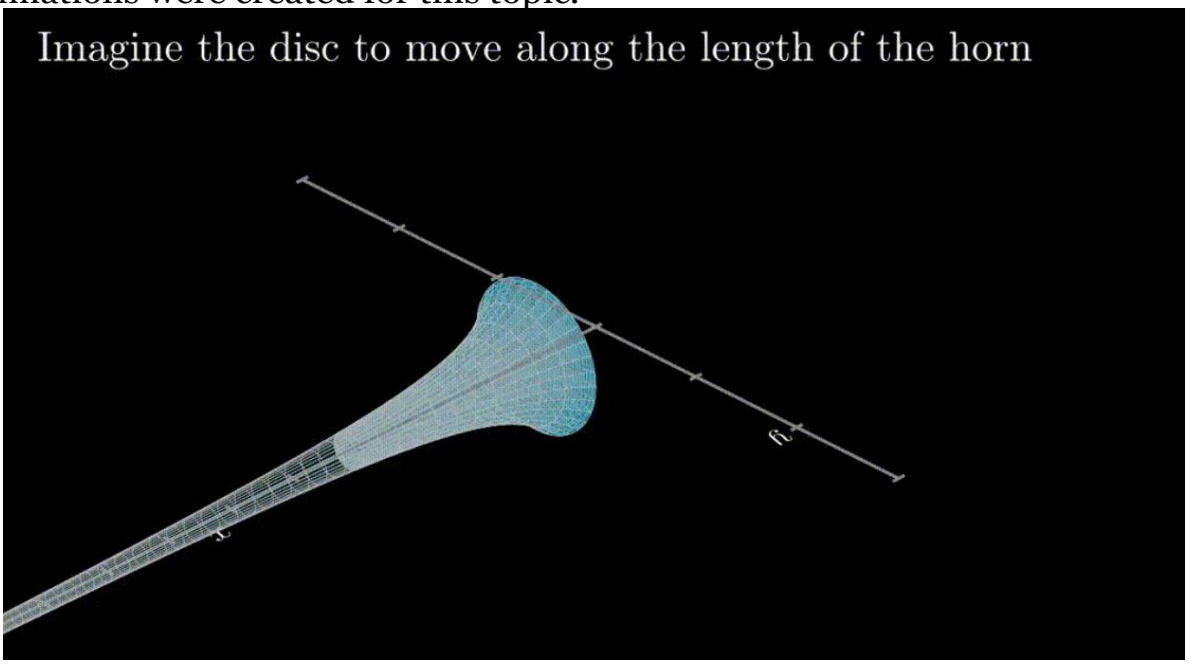


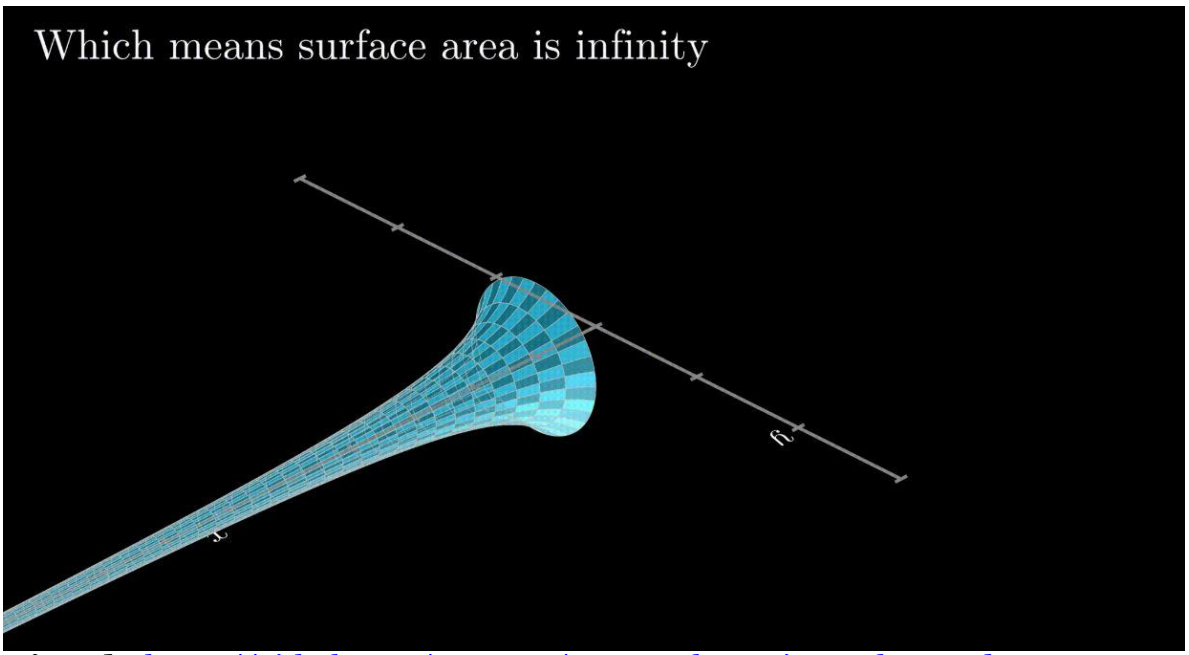
GitHub: https://github.com/FOSSEE/FSF-mathematics-python-code-archive/tree/master/FSF-2020/calculus/intro-to-calculus/infinite-seq-and-series

The volume and surface area of Gabriel' s horn

Link for the subtopic

The volume and surface area of Gabriel's horn is derived. Disc method is used to derive the volume. The volume of the horn isπunit cc. The surface area of the horn is infinity. The painter's paradox is a condition which tells us that a bucket filled with paint would completely fill the horn but the same paint would not be able to paint the surface of the trumpet. The reader would learn that if infinitely many finite quantities can accumulate to give a finite value if the finite quantities become negligibly small quick enough. A total of 3 animations were created for this topic.



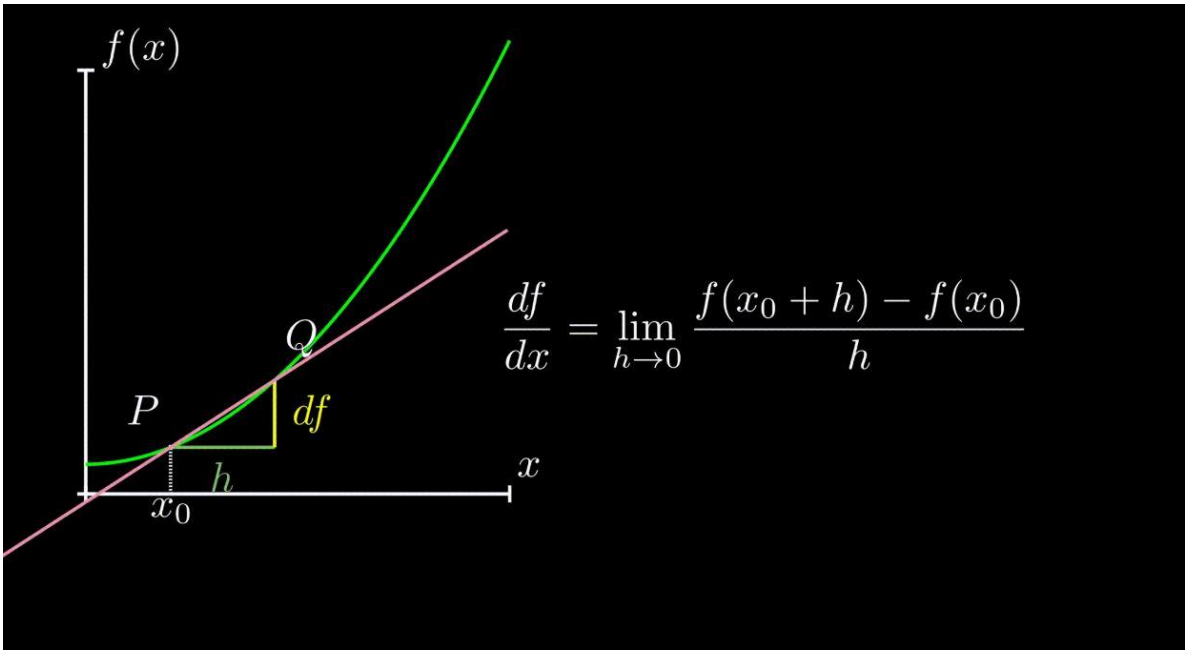


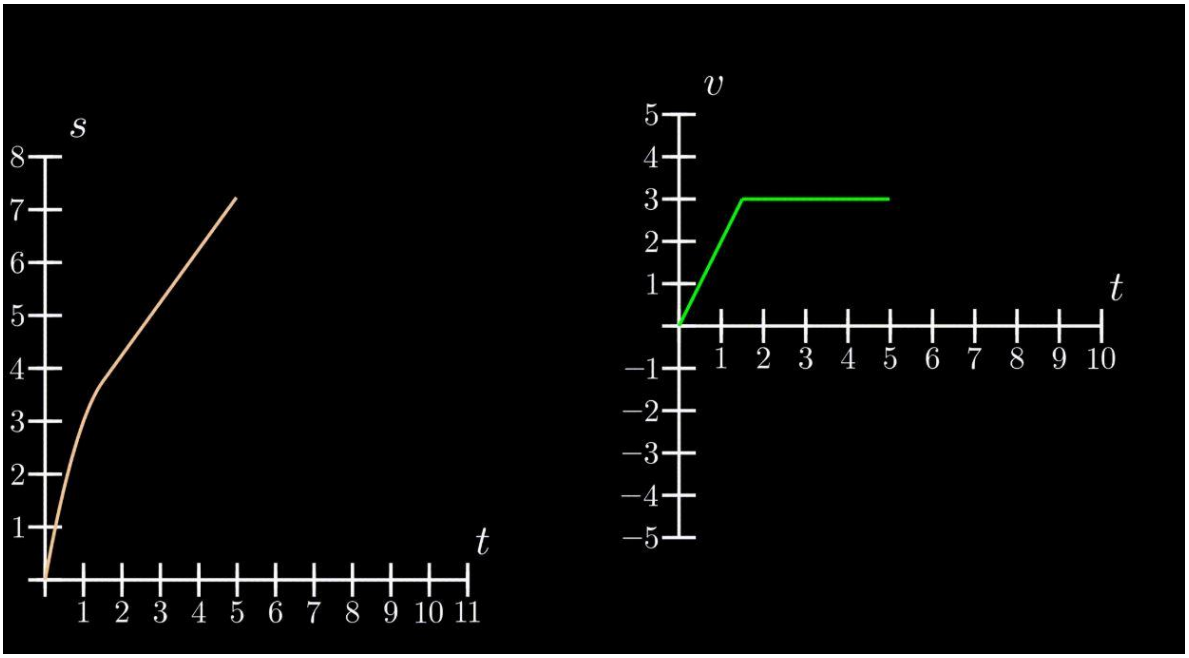
GitHub: https://github.com/FOSSEE/FSF-mathematics-python-code-archive/tree/master/FSF-2020/calculus/intro-to-calculus/gabriels-horn

How fast am I going? – Intro to derivatives

Link for the subtopic

Initially, elementary concept of slope is used to show the fundamental reason behind studying derivatives. The definition of derivative is explained by using limits. The conditions for a derivative to exist at a point are briefly mentioned. Then a realistic example is taken and velocity-displacement relation is explained. A total of 3 animations were created for this topic.





GitHub: https://github.com/FOSSEE/FSF-mathematics-python-code-archive/tree/master/FSF-2020/calculus/intro-to-calculus/intro-to-derivative

Conclusion

I learned a lot about Calculus and Gabriel's horn in particular. Also, this fellowship helped to understand the power of animations. I figured out that one can understand the concepts visually in a much easier way than the standard methodology of teaching. Mathematical concepts suddenly became a lot easier to understand and hard to forget. I think after this fellowship, I am much more efficient in completing the tasks assigned. In the end, I would like to thank all the people who helped me in the construction of these lecture notes. My experience with FOSSEE was exceptionally helping in enhancing my mathematical knowledge. It was a very memorable experience.