



COMPUTATIONAL MATHEMATICS WITH SAGEMATH

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Department of Mathematics

Institute of Chemical Technology, Mumbai

PRE-REQUISITES : Basic knowledge of Calculus, Linear Algebra and ODE and Numerical Methods.

INTENDED AUDIENCE : UG and PG students of Mathematics and BE Students, Teachers teaching in Degree colleges.

INDUSTRIES APPLICABLE TO : Any industry dealing with Data Science and Numerical Computations.

COURSE OUTLINE :

Computational Mathematics with SageMath: This eight week course aims to use SageMath, a Python based free and open source computer algebra system (CAS) to explore concepts in Calculus, Applied Linear Algebra and Numerical Methods. The course will begin with the introduction of basic Python programming language in the first two weeks. Next we shall provide a quick introduction to SageMath software along with plotting 2D and 3D objects. The main focus will be on using SageMath to explore topics in Calculus, Applied Linear Algebra and Numerical Method along with several applications.

ABOUT INSTRUCTOR :

Prof. Ajit Kumar is an Associate Professor and the Head, Department of Mathematics, Institute of Chemical Technology. He did his Masters and Ph.D. from the University of Mumbai. His current areas of interest are Optimization Techniques, Data Analysis, and Mathematical Pedagogy. He has been a prolific user of various mathematical software such as SageMath, Python, R, Mathematica, MatLab etc. Due to this expertise, he has been invited to give talks on these topics at several national and international events and has conducted numerous training programmes for students and teachers. He has been associated with one of the most popular and significant training programmes in Mathematics known as "Mathematics Training and Talent Search, MTTTS" Programme for the last several years in various capacities. Currently he is the managing trustee of the MTTTS TRUST, which organizes all the programmes under the MTTTS umbrella.

COURSE PLAN :

Week 1: Installation of Python; Getting Started with Python Python as an advanced calculator; Lists in Python Tuple, Sets and Dictionaries in Python; Functions and Branching.

Week 2: For loop in Python; While loop in Python; Creating Modules and Introduction to NumPy; Use of NumPy module; Python Graphics using Matplotlib

Week 3: Use of SciPy and SymPy in Python; Classes in Python - Part 01; Classes in Python - Part 02; Introduction and Installation of SageMath; Exploring integers in SageMath

Week 4: Solving Equations in SageMath; 2d Plotting with SageMath; 3d Plotting with SageMath; Calculus of one variable with SageMath - Part 1; Calculus of one variable with SageMath - Part 2; Applications of derivatives

Week 5: Integration with SageMath; Improper Integral using SageMath; Application of integration using SageMath; Limit and Continuity of real valued functions; Partial Derivative with SageMath; Local Maximum and Minimum

Week 6: Application of local maximum and local minimum; Constrained optimization using Lagrange multipliers; Working with vectors in SageMath; Solving system of linear Equations in SageMath; Vector Spaces in SageMath ; Basis and dimensions of vector spaces in SageMath

Week 7: Matrix Spaces with SageMath; Linear Transformations Part 1 with SageMath; Linear Transformations Part 2 with SageMath; Eigenvalues and Eigenvectors Part 1 with SageMath; Eigenvalues and Eigenvectors Part 2 with SageMath

Week 8: Inner Product Part 1 with SageMath; Inner Product Part 2 with SageMath; Orthogonal Decomposition with SageMath; Least Square Solution with SageMath; Singular Value Decomposition (SVD) with SageMath; Application of SVD to image processing; Solving System of linear ODE using Eigenvalues and Eigenvectors; Least Square Solution with SageMath; Singular Value Decomposition (SVD) with SageMath; Application of SVD to image processing; Solving System of linear ODE using Eigenvalues and Eigenvectors

Week 9: Google Page Rank Algorithm using SageMath; Finding Roots of algebraic and transcendental equations in SageMath; Numerical Solutions of System of linear equations in SageMath ; Interpolations in SageMath Numerical Integration in SageMath; Numerical Eigenvalues

Week 10: Solving 1st and 2nd order ODE with SageMath; Euler's Method to solve 1st order ODE with SageMath; Fourth Order Runge-Kutta Method ; RK4 method for System of ODE and Applications; Solving ODE using Laplace Transforms in SageMath

Week 11: Introduction to Linear Programming Problems (LPP); Solving Linear Programming Problems using Graphical Methods; Basics Definitions and Results in LPP; Theory of Simplex Method; Simplex Methods in SageMath - Part 01; Simplex Methods in SageMath - Part 02; Simplex Methods in Matrix Form.

Week 12: Revised Simplex Method in SageMath; Two Phase Simplex Method in SageMath; Big-M Method in SageMath Duality of Linear Program; Dual Simplex Method in SageMath; Review and What next in SageMath?