DEPARTMENT OF MATHEMATICS, COCHIN UNIVERSITY OF SCIENCE AND TECHNOLOGY (CUSAT)

Advanced Mathematical Foundations of Machine Learning and Deep Learning Optimization

Summer Internship Programme · June 2026 · Offline · 120 Hours

ONE MONTH INTENSIVE ◇ **OFFLINE MODE** ◇ **MAXIMUM 30 PARTICIPANTS (LIMITED SEATS)**

ABOUT THE DEPARTMENT

The combined Department of Mathematics and Statistics came into existence in November 1976 and bifurcated to form an independent Department of Mathematics on 1st January, 1996. The Department conducts IM.Sc, MSC and Ph.D. programmes. Areas of research are Algebra, Semi groups Theory, Functional Analysis, Framelets, Numerical Solution of PDE, Graph Theory, Optimization in Neural Networks, Wavelet Approximation, Operator Algebras, Operator theory and Convex Optimization, algorithms and their convergence and complexity analysis.

RELEVANCE OF THE PROGRAMME

- Develop the **mathematical intuition required to understand how machine learning and AI algorithms work**.
- Understand how to implement core ideas independently from mathematical principles.
- Develop Knowledge on how to implement core algorithms from scratch in Python.
- Develop strong conceptual foundation that remains useful even as specific algorithms and software tools change over time.

WHO CAN APPLY

Prerequisites: Undergraduate-level Calculus and Linear Algebra.

- PG students & Research Scholars in Mathematics, Statistics, Physics, Computer Science, Data Science, Artificial Intelligence, and Engineering who seek strong theoretical grounding in ML/AI.
- Final-year UG students in Mathematics.
- Participants are encouraged to bring their own laptops for effective hands-on implementation.

PROGRAMME MODULES

I Mathematical Foundations & Geometry — Days 1–7 · 42 hrs

Geometric Structure of Matrix Operations & Four Fundamental Subspaces; Matrix Factorisation: LU, Orthogonality & QR Decomposition; Spectral Structure, Eigenvalues & Positive Definiteness; Singular Value Decomposition (SVD) & Geometric Approximation; PCA & Optimal Low-Rank Approximation

II Optimisation in Machine Learning — Days 8–14 · 42 hrs

Vector Calculus: Gradients, Jacobians, Hessians & Backpropagation; Linearisation, Taylor Expansions & Loss Landscape Analysis; Gradient Descent, Stochastic GD & Mini-Batch Methods; Momentum, AdaGrad, RMSProp & Adam; Newton's Method & Second-Order Optimisation; Quasi-Newton Methods

III Deep Learning Architectures — Days 15–20 · 36 hrs

Multilayer Perceptrons (MLPs) from Scratch; Training: Backpropagation, GD, SGD & Adam; Recurrent Networks & LSTM Models for Sequence Data; Convolutional Neural Networks for Vision Tasks; Attention Mechanisms and Transformer Models: Query Key Value Framework, Multi Head Attention, and Positional Encoding.

Total duration: 20 working days × 6 hours per day = 120 hours.

Each day, there will be lecture and tutorial hours with documentation of notes in LaTeX, discussions and Python implementation.

120 HOURS OF RIGOROUS MATHEMATICAL TRAINING

APPLICATION PROCESS

Interested candidates may apply through the registration link. After scrutiny of the applications, shortlisted candidates will be notified by email regarding the subsequent proceedings.

IMPORTANT DATES

Registration Opens	April 07, 2026
Registration Closes	April 28, 2026
Programme Dates	June 1 onwards, 2026 (One month)
Mode	Offline

REGISTRATION FEE

Rs. 6,000

per participant (non-refundable) — Click here to register →

ACCOMMODATION

Participants are required to make their own arrangements for food and accommodation.

PROGRAMME COORDINATION

Co-ordinators

Dr. Linu Pinto
Assistant Professor

Dr. Shery Fernandez
Professor & Head of Department

CONTACT

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