GANPAT UNIVERSITY

FACULTY OF ENGINEERING & TECHNOLOGY

Programme	Master of Technology	Branch/Spec.	Computer Engineering (Artificial Intelligence)
Semester	I	Version	1.0.0.0
Effective from Academic Year	2025-26	Effective for the Batch admitted in	July 2025
Course Code	3CEAI101	Course Name	Foundations of AI

Teaching Scheme						Examination Scheme (Marks)			
(Per week)	Lecture (DT)		Practical (Lab.)		Total		CE	SEE	Total
	L	TU	P	TW					
Credit	3	-	1	-	4	Theory	50	50	100
Hours	3	-	2	-	5	Practical	30	20	50

Pre-requisites

Basic engineering mathematics and coding

Course Outcomes

On successful completion of the course, the students will be able to:

CO1	Understand and explain fundamental data structures and algorithmic techniques such as trees, heaps, hash tables, graph algorithms, and sorting/searching methods.
CO2	Apply algorithmic design paradigms like divide-and-conquer, dynamic programming, and greedy algorithms to solve computational problems efficiently.
CO3	Analyze and evaluate linear algebra and calculus-based techniques (e.g., matrix decomposition, gradient descent, eigen analysis) for optimization and mathematical modeling in computing.
CO4	Construct probabilistic models using distributions, Bayes theorem, and statistical inference techniques for solving data-driven problems.

Theory Syllabus

Unit	Content	Hrs.
1	**Introduction to Data Structures and Algorithms** Basic data structures (linked list, stack, queue, trees, heap), Definition and elements of algorithms, characterizing running times, asymptotic running times	3
2	**Searching and Sorting** Binary Search Tree, Priority Queue, Sorting algorithms, Hash tables and hashing techniques	6
3	**Graph Algorithms** Graphs, Depth-first and Breadth-first search, Minimum Spanning Tree algorithms, Shortest-path algorithms	6
4	**Algorithm Design Paradigms** Divide-and-Conquer, Dynamic Programming, Greedy Algorithms with examples	6
5	**Matrix Algebra** Systems of linear equations, vector spaces, subspaces, linear dependence, independence, basis, linear transformations, rank, Inner product, norms of a vector, orthogonality, orthonormal basis, cosine, similarity, orthogonal matrices, eigenvalues and eigenvectors, Spectral, decomposition for real symmetric matrices, SVD	8
6	**Calculus and Optimization** Differentiation of functions of single and several variables, gradient and Hessian, Taylor's formula, Gradient of vector valued functions, higher order derivatives, linearization and multivariate Taylor's formula, Optimization of functions of several variables, characterization of stationary points, Constrained optimization, Lagrange multiplier approach Gradient free optimization methods for non-smooth optimization problems	8
7	**Probability** Axiomatic definition of probability, probability rules, Bayes Theorem, Random variables, pmfs and pdfs, CDF, Expectations, moments, Law of large numbers and central limit theorem, Special distributions, comparing probability distributions	8

Practical Content

Practical, assignments and tutorials are based on above syllabus.

Text Books

1	Thomas H Cormen, Charles E Lieserson, Ronald L Rivest and Clifford Stein, Introduction to Algorithms, 4th Edition, MIT Press, 2022.
2	Jon Kleinberg and Eva Tardos, Algorithm Design, 1st Edition, Pearson, 2005.
3	Mathematics of Machine Learning, M. P. Deisenroth, A. A. Faisal, C. S. Ong, Cambridge University Press, 2020.
4	Linear Algebra and Optimization for Machine Learning, Charu C. Aggarwal, Springer, 2020
Reference Books	
1	1) Sanjoy Dasgupta, Christos H. Papadimitriou and Umesh V. Vazirani, Algorithms, Tata McGraw-Hill, 2008.
2	Michael T Goodrich and Roberto Tamassia, Algorithm Design: Foundations, Analysis, and Internet Examples, Second Edition, Wiley, 2006.
3	Optimization for Data Analysis, S. Wright and B. Recht, Cambridge University Press, 2022.
4	Introduction to Applied Linear Algebra: Vectors, Matrices and Least Squares, S. Boyd and L. Vandenberghe, Cambridge University Press, 2018.
ICT/MOOCs Reference	
1	https://onlinecourses.nptel.ac.in/noc25_cs136/preview

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	0	1	0	1	0	0	2	2	2
CO2	3	2	1	1	1	0	1	0	1	0	0	2	2	2
CO3	3	3	2	3	1	1	3	0	2	0	1	3	2	3
CO4	3	3	2	3	3	1	3	0	2	0	1	3	3	3