GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Master of Engineering

Level: PG

Branch: Information Technology

Course / Subject Code : ME01000691

Subject Name: Maths for Machine Learning

WEF Academic Year:	2024-25
Semester:	1st Semester
Category of the Course:	PCC

Prerequisite:	Basic Knowledge of Mathematics
Rationale:	Machine learning is a domain which requires strong fundamentals of mathematics. At PG level, direct use of library functions of various machine learning algorithms is not sufficient. It is very much crucial to understand mathematical concepts behind these algorithms. This course aims to clear all concepts of learner.

Course Scheme:

Teaching Scheme			Total Credits	Assessment Pattern and Marks				Total Marks
				Theory		Practical		
L	T	PR	C	ESE (E)	PA(M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Course Content:

Sr. No.	Course Content	No. of Hours	% of Weightage
1	Vectors and Matrices Matrix Introduction, Matrix Addition, Matrix Multiplication, Determinant, Transpose of a Matrix, Inverse of a Matrix, Matrix Multiplication using Python, Matrix factorization, Diagonalization Vector introduction, Basis and Dimension, Vector Spaces, Vector Operations, Vector Spaces and Sub spaces, Eigenvalues and Eigenvectors	6	15
2	Statistics Mean, Standard Deviation, and Variance, use NumPy Arrays, Sample Error and True Error Bias Vs Variance and Its Trade-Off Hypothesis Testing T-test Paired T-test, p-value, F-Test, z-test, Confidence Intervals, Correlation and Covariance, Correlation Coefficient,	6	15

	Covariance Matrix, Normal Probability Plot, Q-Q Plot, Residuals Leverage Plot, Hypothesis Testing, Null and Alternative Hypothesis, Type 1 and Type 2 Errors p-value interaction, Parametric Hypothesis Testing, T-test, Paired Samples t-test, ANOVA Test, Non-Parametric Hypothesis Testing, Mann-Whitney U test, Wilcoxon signed-rank test		
3	Estimation Methods Bayesian Estimation, Least Square Estimation, Maximum Likelihood Estimation, Likelihood Function and Log-Likelihood Function Properties of Estimation, Unbiasedness, Consistency, Sufficiency, Completeness, Robustness, Confidence Intervals	6	15
4	Vector Operations Inner, Outer, Cross Products, Distance Between Two Points, Distance Measures, Euclidean Distance, Manhattan Distance, Minkowski Distance, Chebysev Distance, Similarity Measures, Cosine Similarity, Jaccard Similarity , Pearson Correlation Coefficient, Spearman's Rank Correlation Measure, Orthogonality and Orthogonal Projections, Orthogonality and Orthonormal Vectors, Orthogonal Projections	7	15
5	Calculus Differentiation, Inverse Trigonometric Functions Differentiation, Logarithmic Differentiation, Partial Differentiation, Advanced Differentiation, Mathematical Intuition Behind Gradients and their usage, Implementation of Gradients using Python, Optimization Techniques using Gradient Descent, Higher-Order Derivatives, Multivariate Taylor Series, Application of Derivation, Application of Derivative – Maxima and Minima, Absolute Minima and Maxima, Constrained Optimization, Unconstrained Optimization, Constrained Optimization – Lagrange Multipliers, Newton's Method, Uni-variate Optimization, Multivariate Optimization, Convex Optimization, Lagrange's Interpolation, Area Under Curve	7	15
6	Probability Chance and Probability, Addition Rule for Probability, Law of total probability, Bayes' Theorem, Discrete Probability Distributions, Discrete Uniform Distribution, Bernoulli Distribution, Binomial Distribution, Poisson Distribution, Continuous Probability Distributions, Continuous Uniform Distribution, Exponential Distribution, Normal Distribution, Beta Distribution, Beta Distribution of First Kind, Beta Distribution of Second Kind	7	15

	, Gamma Distribution, Sampling Distributions, Chi-Square Distribution, F – Distribution, t – Distribution, Central Limit Theorem, Implementation of Central Limit Theorem, Law of Large Numbers, Change of Variables/Inverse Transformation		
7	Introduction to Dimensionality Reduction Mathematical Intuition Behind PCA, PCA implementation in Python	6	10
	Total	**45**	**100**

Reference Book:

1. Introduction to Machine Learning, by Jeeva Jose, Khanna Book Publishing, 2020.
2. Linear Algebra and Learning from Data (2019), Gilbert Strang, Wellesley Cambridge Press
3. "Machine Learning: A Probabilistic Perspective" By Kevin P. Murphy (MIT Press), 2021 edition
4. Deisenroth MP, Faisal AA, Ong CS. Mathematics for machine learning. Cambridge University Press;

Course Outcomes:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level*
01	Understand concepts related to matrix and vector	UN
02	Understand and apply probability and algebra concepts	UN, AP
03	Understand and apply vector concepts	UN, AP
04	Analyze and evaluate various hypothesis techniques	AN, EL

*RM: Remember, UN: Understand, AP: Apply, AN: Analyze, EL: Evaluate, CR: Create

Suggested Course Practical List:

At least 15 practical related to the course must be carried out during semester.

List of Laboratory/Learning Resources Required:

- Python
- Google COLAB
- ANACONDA and Jupiter notebook
- Python libraries for ANN and Deep Learning

* * * * * * *