20MA503T					Mathematics for Data Science					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- Use computational techniques and algebraic skills essential for the study of systems of linear equations, matrix algebra, vector spaces, eigenvalues and eigenvectors, orthogonality, and diagonalization.
- Work collaboratively with peers and instructors to acquire mathematical understanding and to formulate and solve problems and present solutions for data science applications.

Unit 1 MATRICES AND BASIC OPERATIONS 10 Hrs

Matrices and Basic Operations, interpretation of matrices as linear mappings, and some examples, Properties of determinants, singular and non-singular matrices, examples, finding an inverse matrix Characteristic Polynomial, Definition of Left/right Eigenvalues and Eigenvectors, Caley-Hamilton theorem, Singular Value Decomposition: Principal Component Analysis, Interpretation of eigenvalues/vectors.

Unit 2 NORMED SPACES, VECTOR SPACES 10 Hrs

Definition of complete normed and vector spaces and some examples. Matrix norms and properties, The Range and the Null space of a Matrix- Definition and basic properties, orthogonality, Orthogonal transformations, Gram-Schmidt algorithm, From Gauss to LU factorization, Definition of positive-definiteness and the role of the eigenvalues, Eigenvalue problems.

Unit 3 LINEAR SYSTEMS 10 Hrs

Definition, applications, solving linear systems, linear inequalities, linear programming, Real-valued functions of two or more variables, Analysis elements Distance, Limits, continuity, differentiability, the gradient and the Hessian, Linear Bandits and Matrix Completion Methods, Sparse linear algebra: Sparse matrices and sparse solutions.

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Unit 4 OPTIMIZATION PROBLEMS 10 Hrs

Motivation, the role of the Hessian, maxima and minima and related extrema conditions, Elements of Convex Optimization Functions of n variables. Convex sets, convex functions, convex problems, and their basic properties. Examples of convex problems, convexity versus non-convexity, Why We Need Gradient Descent, Convergence of Gradient Descent, The Divergence Problem, Bivariate Optimization, Multivariate Optimization.

Total: 40 Hrs

COURSE OUTCOMES

On completion of the course, student will be able to:
CO1: Interpret existence and uniqueness of solutions using matrix algebra.
CO2: Apply equivalent forms to identify matrices and solve linear systems.
CO3: Apply basic properties of subspaces and vector spaces.
CO4: Compute the orthogonal projection of a vector onto a subspace, given a basis for the subspace.
CO5: Critically analyze and construct mathematical arguments that relate to the study of introductory linear algebra.
CO6: Apply optimization methods and algorithms developed for solving various types of optimization problem.

TEXT/REFERENCE BOOKS

1. Lloyd N. Trefethen and David Bau, “Numerical Linear Algebra” III, SIAM, Philadelphia, ISBN 0-89871-361-7
2. Charu C. Agarwal, Linear Algebra & Optimization for Machine Leaning, Springer, 2020.
3. Gilbert Strang, Linear Algebra and Its Applications, Thomson/Brooks Cole
4. Stephen Boyd, Lieven Vandenberghe , Introduction to Applied Linear Algebra, Cambridge University press, 2018.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Part A: 10 Questions of 2 marks each-No choice 20 Marks
Part B: 2 Questions from each unit with internal choice, each carrying 20 marks 80 Marks