

Semester: 2				
Programme: Data Science				
Course: Calculus and Linear Algebra 2				
Paper code: C1DS250221T			Credits: 4	
Hours/week: 4				
Category: Core				
Theory / Practical / Composite: Theory				
No of Module: 2				
Course Outcome:				
1. Remember fundamental definitions and statements of results regarding limits, continuity, differentiability, Riemann integration, eigenvalues, eigenvectors, and linear transformations.				
2. Understand the conceptual framework of pointwise and uniform convergence for sequences of functions, the properties of vector differentiation (gradient, divergence, and curl), and the structural logic of matrix decompositions.				
3. Apply Taylor's theorem, row reduction techniques, and the properties of Beta and Gamma integrals to solve systems of linear equations and perform function approximations.				
4. Analyze the behaviour of real-valued functions through derivatives and assess the structural properties of linear transformations, including kernel, image, rank, and nullity.				
5. Evaluate the convergence of power series using mathematical tests and judge the effectiveness of quadratic forms and Singular Value Decomposition (SVD) for matrix compression and low-rank approximations.				
6. Create integrated mathematical solutions for data science problems by synthesizing multivariable calculus concepts, such as double integrals, with advanced linear algebra paradigms like SVD for dimensionality reduction				
Prerequisites: Basic knowledge about any prior course				
SYLLABUS				
Module/Unit	CONTENT	HOURS or NUMBER OF CLASSES	CO Mapping	COGNITIVE LEVEL
Module 1 / Unit 1	Limits, Continuity, Differentiability and Applications Limits of real-valued functions: Definition, sequential limits, properties. Continuity: Definition, intermediate value property, discontinuous functions. Differentiability: Definition, chain rule, Rolle's Theorem. Taylor's theorem, remainder terms. Maxima and minima of functions. L'Hospital's rule of limits. Statements of results and applications.	10	CO1, CO3, CO4	K1, K3, K4
Module 1 / Unit 2	Integration Introduction to Riemann Integration – Definition, Basic Concepts and Properties. Improper Integrals – Definition & Examples, Simple Tests for Convergence of Improper	6	CO1, CO3, CO5	K1, K3, K5

	Integrals. Beta and Gamma Integrals – Definitions, Evaluations and Properties.			
Module 1 / Unit 3	Sequences and Series of Functions Pointwise and Uniform Convergence, Properties of Uniformly Convergent Functions, Weierstrass’ M-Test for Series Convergence. Power Series – Radius of Convergence, Tests and Properties	5	CO2, CO5	K2, K5
Module 1 / Unit 4	Analysis of Functions in Two Variables Introduction to Functions of Two Variables – Partial Differentiation and Total Differentiation. Vector Differentiation – Gradient, Divergence & Curl. Double Integrals	5	CO2, CO6	K2, K6
Module 2 / Unit 1	Solution of a System of Linear Equations: Elementary matrices and row operations. Row reduction techniques and echelon forms. Solution of System of linear equations.	5	CO3	K3
Module 2 / Unit 2	Eigenvalues and Eigenvectors Definition and computation of eigenvalues and eigenvectors. Properties of eigenvalues and eigenvectors. Statement and applications of the CayleyHamilton Theorem. Diagonalization of matrices.	6	CO1, CO4	K1, K4
Module 2 / Unit 3	Linear Transformations Definition. Matrix representation of a linear transformation. Kernel and image, rank and nullity in the transformation context. Applications in projections and dimensionality reduction.	5	CO1, CO4, CO6	K1, K4, K6
Module 2 / Unit 4	Quadratic Forms Definition. Classification. Canonical reduction of quadratic forms. Rank and signature.	6	CO1, CO5	K1, K5
Module 2 / Unit 5	Singular Value Decomposition (SVD): Definition and interpretation. Decomposition of any real matrix into orthogonal and diagonal components. Use of SVD in computing pseudoinverses, low-rank approximations, and matrix compression.	4	CO1, CO5, CO6	K1, K5, K6

Text Books

1. Bertle R. G., Sherbert D. R. (2011): Introduction to Real Analysis, 4th Edition, Wiley & Sons Inc.
2. Goldberg R. R. (2020): Methods of Real Analysis, Oxford & IBH Publishing Co Pvt Ltd.
3. Khuri A. (2003): Advanced Calculus with Applications in Statistics, 2nd Edition, Wiley Interscience.
4. Rudin W. (2017): Principles of Mathematical Analysis, 3rd Edition, McGraw Hill Publication.
5. Marsden, J. E., & Tromba, A. J. (2003). Vector Calculus (5th ed.). W. H. Freeman.
6. Hadley G. (2002): Linear Algebra. Narosa Publishing House (Reprint).
7. Kenneth H. and Kunze R. (1978): Linear Algebra. Phi Learning Pvt Ltd.

8. Mapa S. K. (2016): Higher Algebra: Abstract and Linear. Levant Books.		
9. Rao A. R. and Bhimasankaram P. (2000): Linear Algebra. Hindustan Book Agency.		
10. Strang, G. (2016): Introduction to Linear Algebra (5th Edition). WellesleyCambridge Press.		
11. Shakiban, C., & Olver, P. J. (2018): Applied Linear Algebra (2nd Edition). Pearson.		
Evaluation	CIA: 30 Semester exam: 70 Total: 100	
Paper Structure for Theory Semester Exam Module :	Module-I (35 marks)	Module-II (35 marks)
	To answer Short: 4 out of 6 (5 marks) Long: 1 out of 2 (15 marks)	To answer Short: 4 out of 6 (5 marks) Long: 1 out of 2 (15 marks)

Course outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive levels
CO1	Remember fundamental definitions and statements of results regarding limits, continuity, differentiability, Riemann integration, eigenvalues, eigenvectors, and linear transformations.	K1
CO2	Understand the conceptual framework of pointwise and uniform convergence for sequences of functions, the properties of vector differentiation (gradient, divergence, and curl), and the structural logic of matrix decompositions.	K2
CO3	Apply Taylor's theorem, row reduction techniques, and the properties of Beta and Gamma integrals to solve systems of linear equations and perform function approximations.	K3
CO4	Analyze the behavior of real-valued functions through derivatives and assess the structural properties of linear transformations, including kernel, image, rank, and nullity.	K4
CO5	Evaluate the convergence of power series using mathematical tests and judge the effectiveness of quadratic forms and Singular Value Decomposition (SVD) for matrix compression and low-rank approximations.	K5
CO6	Create integrated mathematical solutions for data science problems by synthesizing multivariable calculus concepts, such as double integrals, with advanced linear algebra paradigms like SVD for dimensionality reduction	K6