Semester	**ONE**
Course	**Major**
Paper Code	**C1DS250221T**
Paper Title	**Calculus and Linear Algebra 2**
No. of Credits	**4**
Theory/Composite/ Practical	**Theory**
Minimum No. of preparatory hours per week a student has to devote	**Module 1: 2** **Module 2: 2**
Number of Module	**TWO**
Syllabus	**Module-I** **Unit 1:** Limits, Continuity, Differentiability and Applications [10L] 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. **Unit 2:** Integration [6L] Introduction to Riemann Integration – Definition, Basic Concepts and Properties. Improper Integrals – Definition & Examples, Simple Tests for Convergence of Improper Integrals. Beta and Gamma Integrals – Definitions, Evaluations and Properties. **Unit 3:** Sequences and Series of Functions [5L] Pointwise and Uniform Convergence, Properties of Uniformly Convergent Functions, Weierstrass' M-Test for Series Convergence. Power Series – Radius of Convergence, Tests and Properties. **Unit 4**: Analysis of Functions in Two Variables [5L] Introduction to Functions of Two Variables – Partial Differentiation and Total Differentiation. Vector Differentiation – Gradient, Divergence & Curl. Double Integrals. **Module-II** **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] **Unit 2:** Eigenvalues and Eigenvectors: Definition and computation of eigenvalues and eigenvectors. Properties of eigenvalues and eigenvectors. Statement and applications of the Cayley-Hamilton Theorem. Diagonalization of matrices. [6] **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] **Unit 4:** Quadratic Forms: Definition. Classification. Canonical reduction of quadratic forms. Rank and signature. [6] **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]
Learning Outcomes	• Applying fundamental concepts of real analysis to analyze the behavior of numerical methods and optimization techniques used in data science. • Evaluating the convergence of sequences and series using mathematical tests. • Utilizing set theory, logic, and relations to model data structures, relational databases, and logical reasoning in artificial intelligence. • Applying row operations and echelon forms to solve systems of linear equations. • Analyzing eigenvalues, eigenvectors, and linear transformations to assess matrix diagonalizability and applications in dimensionality reduction. • Evaluating matrices using quadratic forms and singular value decomposition (SVD).

<table>
<tr><td>Reading/Reference List</td><td colspan="2">Bertle R. G., Sherbert D. R. (2011): Introduction to Real Analysis, 4th Edition, Wiley & Sons Inc.
Goldberg R. R. (2020): Methods of Real Analysis, Oxford & IBH Publishing Co Pvt Ltd.
Khuri A. (2003): Advanced Calculus with Applications in Statistics, 2nd Edition, Wiley Interscience.
Rudin W. (2017): Principles of Mathematical Analysis, 3rd Edition, McGraw Hill Publication.
Marsden, J. E., & Tromba, A. J. (2003). Vector Calculus (5th ed.). W. H. Freeman.
Hadley G. (2002): Linear Algebra. Narosa Publishing House (Reprint).
Kenneth H. and Kunze R. (1978): Linear Algebra. Phi Learning Pvt Ltd.
Mapa S. K. (2016): Higher Algebra: Abstract and Linear. Levant Books.
Rao A. R. and Bhimasankaram P. (2000): Linear Algebra. Hindustan Book Agency.
Strang, G. (2016): Introduction to Linear Algebra (5th Edition). Wellesley-Cambridge Press.
Shakiban, C., & Olver, P. J. (2018): Applied Linear Algebra (2nd Edition). Pearson.</td></tr>
<tr><td>Evaluation</td><td colspan="2">CIA: 30
Semester exam: 70
Total: 100</td></tr>
<tr><td rowspan="2">Paper Structure for Theory Semester Exam</td><td>Module-I (35 marks)</td><td>Module-II (35 marks)</td></tr>
<tr><td>To answer Short: 4 out of 6 (5 marks)
Long: 1 out of 2 (15 marks)</td><td>To answer Short: 4 out of 6 (5 marks)
Long: 1 out of 2 (15 marks)</td></tr>
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