DISCIPLINE SPECIFIC CORE COURSE – 3: MATHEMATICS FOR COMPUTING

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course				Eligibility criteria	Pre-requisite c the course (if any)
		Lecture	Tutorial	Practical/ Practice			
Mathematics for Computing	4	3	0	1		Class XII pass	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- Introduces the students to the fundamental concepts and topics of linear algebra and vector calculus.
- To build the foundation for some of the core courses in later semesters.

Learning Outcomes

This course will enable the students to:

- Perform operations on matrices and sparse matrices.
- Compute the determinant, rank and eigenvalues of a matrix.
- Perform diagonalization.
- Perform operations on vectors, the dot product and cross product.
- Represent vectors geometrically and calculate the gradient, divergence, curl.
- Apply linear algebra and vector calculus to solve problems in sub-disciplines of computer science.

SYLLABUS OF DSC – 3

Theory

Unit – 1 **(6 hours)**

Introduction to Matrix Algebra

Echelon form of a Matrix, Rank of a Matrix, Determinant and Inverse of a matrix, Solution of System of Homogeneous & Non-Homogeneous Equations: Gauss elimination and Solution of System of Homogeneous Equations: Gauss Jordan Method.

Unit – 2 **(21 hours)**

Vector Space and Linear Transformation

Vector Space, Sub-spaces, Linear Combinations, Linear Span, Convex Sets, Linear Independence/Dependence, Basis & Dimension, Linear transformation on finite dimensional vector spaces, Inner Product Space, Schwarz Inequality, Orthonormal Basis, Gram-Schmidt Orthogonalization Process.

Unit – 3 **(9 hours)**

EigenValue and EigenVector

Characteristic Polynomial, Cayley Hamilton Theorem, Eigen Value and Eigen Vector of a matrix, Eigenspaces, Diagonalization, Positive Definite Matrices, Applications to Markov Matrices.

Unit – 4 **(9 hours)**

Vector Calculus

Vector Algebra, Laws of Vector Algebra, Dot Product, Cross Product, Vector and Scalar Fields, Ordinary Derivative of Vectors, Space Curves, Partial Derivatives, Del Operator, Gradient of a Scalar Field, Directional Derivative, Gradient of Matrices, Divergence of a Vector Field, Laplacian Operator, Curl of a Vector Field.

Practical **(30 hours)**

List of Practicals:

1. Create and transform vectors and matrices (the transpose vector (matrix) conjugate transpose of a vector (matrix))
2. Generate the matrix into echelon form and find its rank.
3. Find cofactors, determinant, adjoint and inverse of a matrix.
4. Solve a system of Homogeneous and non-homogeneous equations using Gauss elimination method.
5. Solve a system of Homogeneous equations using the Gauss Jordan method.
6. Generate basis of column space, null space, row space and left null space of a matrix space.
7. Check the linear dependence of vectors. Generate a linear combination of given vectors of Rn/ matrices of the same size and find the transition matrix of given matrix space.
8. Find the orthonormal basis of a given vector space using the Gram-Schmidt orthogonalization process.
9. Check the diagonalizable property of matrices and find the corresponding eigenvalue and verify the Cayley- Hamilton theorem.
10. Application of Linear algebra: Coding and decoding of messages using nonsingular matrices.
    eg code “Linear Algebra is fun” and then decode it.
11. Compute Gradient of a scalar field.
12. Compute Divergence of a vector field.
13. Compute Curl of a vector field.

Essential Reading

- Strang Gilbert. Introduction to Linear Algebra, 5th Edition, Wellesley-Cambridge Press, 2021.
- Kreyszig Erwin. Advanced Engineering Mathematics, 10th Edition, Wiley, 2015.
- Strang Gilbert. Linear Algebra and Learning from Data, 1st Edition, Wellesley-Cambridge Press, 2019.
- Jain R. K., Iyengar S.R. K. Advanced Engineering Mathematics, 5th Edition, Narosa, 2016.

Suggestive Reading

- Deisenroth, Marc Peter, Faisal A. Aldo and Ong Cheng Soon. Mathematics for Machine Learning, 1st Edition, Cambridge University Press, 2020.
- (Lipschutz Seymour and Lipson Marc. Schaum's Outline of Linear Algebra, 6th Edition, McGraw Hill, 2017.