Gujarat University
Syllabus
M.Sc. (Artificial Intelligence and Machine Learning) - I

Course Name: Mathematical Foundation

Course Code: MSCAI 111

Objectives:

With the current deployment of computer technology and tools, it is very important to develop the student's geometric insight into the concepts of Calculus, Vectors and Vector Spaces and applying these concepts to real life problems and machine learning problems
Aim of the course is to enable students

- To introduce the Concepts of Calculus, Vectors and Vector Spaces
- To apply these concepts to real life problems and machine learning problems

Prerequisites:

Basic knowledge of Mathematical fundamentals

Contents:

1. **Introduction to Set Theory**
   Basic Concepts, notations, inclusion and equality, power set, operations of union, intersection and complement, Venn diagrams, set identities, ordered pairs and n-tuples, Cartesian product

2. **Introduction to Coordinate Geometry**
   Definition of coordinates and axes, coordinate plane, plotting of points, scatter diagram, general form of a straight line, slope and intercept, distance formula, section formula, mid-point formula angle between two lines, triangle in Cartesian plane, distance of a point from the line, equation of a normal to the line, Equation of plane, hyper plane, equation of normal to plane, to classify point to side of plane

3. **Fundamentals of Single Variable Calculus**
   Functions of single variable, definition and their graphs, special functions like polynomials, trigonometric , exponential , hyperbolic , limit, continuity, definition of derivative and its graphical meaning , rules of differentiation, chain rule, higher order derivatives, definition of integration and its geometric interpretation ,indefinite and definite integral and their evaluation, Optimization of functions : Local Maxima and minima of functions, saddle point, , necessary and sufficient conditions, global maxima, convex functions, Taylor Series

4. **Multivariable Calculus**
   Multivariable functions and their 3 D graphs, contour lines and maps, introduction to partial derivatives and formal definition, graphical meaning, computing of partial derivatives, chain rule, second order partial derivatives and their symmetry, higher order partial derivatives, Gradient and its physical interpretation, properties, directional derivatives, Jacobian, computing Jacobian matrix and its determinant, Lagrange multiplier method for finding local optimum

5. **Fundamentals of Vectors**
   Definition of vector, scalars, addition and subtraction of vectors, scalar multiplication, inner product(dot product) of vectors, norms, direction, orthogonal vectors, projection of vectors, cosine similarity, normal and orthonormal vectors, Gram-Schmidt procedure, orthogonal decomposition

6. **Vector Spaces**
   Vector Space and Subspaces, null Space, row space and column space , linear transformations, linear independence, basis vectors , linear combination, dimension , linear span, change of basis, invariant subspaces

Main Reference Books:

1. Advanced Engineering Mathematics, 10ed, ISV, Erwin Kreyszig, John Wiley & Sons, Inc.
2. Linear Algebra and Its Application, 3rd Edition, David C. Lay, Pearson
3. Introduction to Algorithms, 3rd Ed, Corman, Leiserson, Rivest and Stein, PHI
4. Advanced Mathematics for Engineers, Dr. Chandrika Prasad, Pothishala Private Ltd.
5. Linear Algebra, Kenneth Hoffman, PHI
6. Linear Algebra and Its Applications, Gilbert Strang, Cambridge University Press

Accomplishments of the student after completing the Course:

- Demonstrate the ability to apply mathematical skills for problem solving applications
- Apply mathematical techniques of geometry, calculus and vectors to solve problems
- Represent and evaluate basic mathematical and/or logical information numerically, graphically, and symbolically
- Interpret mathematical and/or logical models such as single and multivariable calculus as well as vectors and vector space

***** ***** *****