GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Computer Applications

Level: UG

Course / Subject Code: BC03001041

Course / Subject Name: Mathematical Foundation for AI

w. e. f. Academic Year:	2025-26
Semester:	3
Category of the Course:	Core Course

Prerequisite:	Basic knowledge of linear algebra, calculus, and probability at the undergraduate level.
Rationale:	Artificial Intelligence (AI) heavily depends on mathematical tools to develop intelligent algorithms. This course aims to establish the mathematical grounding necessary for understanding and designing AI models. Topics such as linear algebra, probability, optimization, and logic are covered to prepare students for core AI and machine learning courses. **Pedagogy**: The course will be delivered using a blend of theoretical instruction and practical problem-solving sessions. Conceptual understanding will be reinforced through interactive tutorials, real-world case studies, and visualization tools. Emphasis will be placed on mathematical derivations, algorithmic applications, and interpretation of results. Students will engage in active learning via hands-on exercises using software tools like Python/NumPy. Periodic quizzes, discussions, and group assignments will be conducted to ensure continuous learning and application.

Course Outcome:

After Completion of the Course, students will be able to:

No	Course Outcomes	RBT Level
01	Apply linear algebra concepts to represent data and model transformations	AP
02	Utilize calculus and optimization techniques for training AI models	AP
03	Explain use of probability theory and statistics for modeling uncertainty in AI	UN
04	Analyze AI algorithms using concepts of logic and set theory	AN
05	Evaluate mathematical approaches for real-world AI problems	EL

**Revised Bloom's Taxonomy (RBT)*

Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
				Theory		Tutorial / Practical		
L	T	PR	C	ESE (E)	PA / CA (M)	PA/CA (I)	ESE (V)	
2	2	0	4	70	30	20	30	150

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1	Linear Algebra for AI: Vectors, matrices, operations, eigenvalues, eigenvectors, SVD	6	20%
2	Probability and Statistics: Probability theory, Bayes theorem, distributions, expectation, variance, law of large numbers	6	20%
3	Calculus and Optimization: Limits, derivatives, partial derivatives, gradient descent, convex functions, Lagrange multipliers	6	20%
4	Discrete Mathematics and Logic: Sets, relations, functions, propositional and predicate logic, inference	6	20%
5	Applications and Case Studies: Mathematical modeling in AI, optimization in neural networks, probabilistic reasoning in ML	6	20%
	TOTAL	30	100%

Suggested Course Tutorials:

1. Matrix operations, SVD, and eigen-decomposition exercises using Python/NumPy
2. Probability distributions and statistical computation tasks
3. Implementation of gradient descent on a simple cost function
4. Truth tables and logical inference problems
5. Optimization exercises using real AI datasets (basic level)

List of Active Learning Assignments:

- Case study: Optimization in logistic regression
- Exploratory data analysis using statistical concepts
- Mathematical logic puzzle solving and proof writing
- Real-world AI problem formulation and mathematical modeling

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (in %)					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
10	20	30	20	20	-

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

1. V. Kumar, "Mathematics for Machine Learning," Cambridge University Press.
2. Sheldon Ross, "Introduction to Probability Models," Academic Press.
3. Gilbert Strang, "Linear Algebra and Its Applications," Cengage Learning.
4. Richard C. Dorf and Robert H. Bishop, "Modern Control Systems" (for optimization insight).

5. Kenneth Rosen, "Discrete Mathematics and Its Applications," McGraw Hill.
6. Stephen Boyd and Lieven Vandenberghe, "Convex Optimization," Cambridge University Press.

CO- PO Mapping:

Semester 3	**Course Name : Mathematical Foundation for AI**										
	POs										
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	2	-	2	-	1	-	-	-	1
CO2	3	3	2	2	2	-	1	-	-	-	1
CO3	3	3	1	2	1	-	1	-	-	-	-
CO4	2	3	2	2	1	-	1	-	-	-	1
CO5	2	3	3	3	2	-	2	1	1	1	2

*Legend: '**3**' for high, '**2**' for medium, '**1**' for low and '**-**' for no correlation of each CO with PO.*

Note: The CO-PO mapping is indicative; the institute/faculty member can change as required.

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