REVA UNIVERSITY
Bengaluru, India
Established as per the section 2(f) of the UGC Act, 1956,
Approved by AICTE, New Delhi

REVA Academy for Corporate Excellence (RACE)

Program: PGD/M.Tech/MS in Artificial Intelligence
Module: II
Module Name: Mathematics and Statistics for AI
Batch: AI11 | Sem 1
Credits: 04
LTP: 1:0:3
Dates: 22nd, 29th November, 6th, 13th and 20th December 2025
Final Exam: January 3rd 2026

Mathematics and Statistics for Artificial Intelligence

Mentor: Yuvaraju M

Syllabus, Lesson Plan and Evaluation

Syllabus and Resources	
Course Description	This foundational course equips learners with the essential mathematical principles that power modern Artificial Intelligence and Machine Learning. It covers core topics in linear algebra, calculus, probability, and statistics, enabling students to model data, analyze uncertainty, and understand optimization processes behind learning algorithms. Through hands-on labs using Python and popular scientific libraries, learners gain practical experience in implementing vector/matrix operations, visualizing gradients, exploring probability distributions, and conducting hypothesis tests. The course culminates in applying dimensionality reduction techniques such as PCA, preparing students to confidently translate mathematical theory into real-world AI applications.
Course Objectives	By the end of this course, learners will be able to: 1. Explain the fundamental concepts of linear algebra, calculus, probability, and statistics relevant to AI and machine learning. 2. Apply vector, matrix, and gradient-based operations to formulate and solve computational problems in AI. 3. Analyze probability distributions and statistical measures to interpret data and model uncertainty in real-world scenarios. 4. Evaluate hypotheses using appropriate statistical tests, confidence intervals, and significance measures. 5. Implement mathematical concepts in Python using NumPy, Pandas, SciPy, and other scientific libraries. 6. Demonstrate dimensionality reduction and optimization techniques (e.g., PCA, gradient descent) on real datasets through hands-on exercises and mini-projects.

CO#	Course Outcomes	POs	PSOs
CO1	Apply linear algebra concepts such as vectors, matrices, and eigenvalues in AI applications.	1, 2, 5	1, 2
CO2	Use calculus to understand optimization and gradient-based learning in machine learning models.	1, 2	4
CO3	Interpret and apply probability distributions to model uncertainty in AI systems.	1, 5	1, 2
CO4	Conduct descriptive and inferential statistics for real-world data analysis.	3, 4	3
CO5	Perform hypothesis testing and evaluate statistical significance in experiments.	4, 5	3, 4
CO6	Translate mathematical foundations into code using Python and relevant libraries.	4, 5	3, 4

For more information, visit the program LMS https://racelms.reva.edu.in/dashboard

Legend: LTP: Lecture:1 Tutorial:0 Practical:3
CIE – Continuous Internal Examination
MEE – Module End Exam

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Course Contents	**Unit 1:** Linear Algebra for AI: Vectors, vector operations, dot and cross product. Matrices, matrix multiplication, rank, inverse, transpose. Eigenvalues and eigenvectors. Applications in dimensionality reduction (PCA). **Unit 2:** Calculus for Optimization: Functions, limits, derivatives, and integrals. Partial derivatives and gradients. Optimization techniques – gradient descent, cost functions, minima/maxima. Use in training machine learning models. **Unit 3:** Probability and Distributions: Set theory, permutations and combinations, conditional probability, Bayes theorem. Discrete and continuous probability distributions (Bernoulli, Binomial, Poisson, Normal). Expectation and variance. **Unit 4:** Statistics and Hypothesis Testing: Descriptive statistics (mean, median, mode, standard deviation). Sampling and central limit theorem. Hypothesis testing – z-test, t-test, p-value, confidence intervals. Correlation vs causation.
Suggested Labs	Lab 1: Implement vector and matrix operations using NumPy. Lab 2: Visualize and compute derivatives and gradients using SymPy and Matplotlib. Lab 3: Simulate probability distributions (Normal, Binomial) using SciPy. Lab 4: Perform exploratory data analysis using real-world datasets with Pandas. Lab 5: Conduct hypothesis testing (t-tests, ANOVA) using Python statistical libraries. Lab 6: Mini project – Apply PCA to reduce dimensionality of a dataset and visualize results.
Tools/Softwares	Python 3.xxx, Google Colab, Jupyter notebook
Books and Resources	**Books** 1. **Applied Linear Algebra and Matrix Analysis** *Thomas S. Shores, Springer* 2. **Mathematics for Machine Learning** *Marc Peter Deisenroth, A. Faisal, C. Ong (Cambridge University Press)* 3. **Probability and Statistics for Engineers and Scientists** *Ronald E. Walpole* **Web Resources** 1. MIT OpenCourseWare – Linear Algebra https://ocw.mit.edu/courses/18-06-linear-algebra-spring-2010

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	2. Khan Academy – Calculus, Probability & Statistics https://www.khanacademy.org/math 3. StatQuest with Josh Starmer (YouTube) – Statistics & intuition https://www.youtube.com/c/statquest 4. Towards Data Science – Practical ML math articles https://towardsdatascience.com/ 5. Brilliant.org – Interactive lessons on probability, linear algebra https://brilliant.org/
Mentor's Profile	Yuvaraju Maddiboina - https://www.linkedin.com/in/yuvarajum/

Lesson Plan		
Day #	**Theory**	**Practice/Lab/Projects**
1.	**Unit 1:** Linear Algebra for AI: Vectors, vector operations, dot and cross product. Matrices, matrix multiplication, rank, inverse, transpose. Eigenvalues and eigenvectors. Applications in dimensionality reduction (PCA).	**Lab 1** Apply vector and matrix operations on synthetic NumPy arrays from scratch to understand linear algebra foundations for AI. **Lab 2** Apply PCA on the Iris dataset from scratch to understand dimensionality reduction using eigenvalues and eigenvectors.
2.	**Unit 2:** Calculus for Optimization: Functions, limits, derivatives, and integrals. Partial derivatives and gradients. Optimization techniques – gradient descent, cost functions, minima/maxima. Use in training machine learning models.	**Lab 3** Apply symbolic differentiation on custom mathematical functions using SymPy to understand gradients in optimization. **Lab 4** Apply gradient descent from scratch on a linear regression dataset to understand how machine learning models learn parameters.
3.	**Unit 3:** Probability and Distributions: Set theory, permutations and combinations, conditional probability, Bayes theorem. Discrete and continuous probability distributions (Bernoulli, Binomial, Poisson, Normal). Expectation and variance.	**Lab 5** Apply Bayes Theorem on a simulated medical diagnosis dataset from scratch to understand conditional probability and posterior estimation. **Lab 6**

Legend: LTP: Lecture:1 Tutorial:0 Practical:3
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		Apply sampling from Binomial, Poisson, and Normal distributions using SciPy to understand real-world probability modeling.
4.	**Unit 4:** Statistics and Hypothesis Testing: Descriptive statistics (mean, median, mode, standard deviation). Sampling and central limit theorem. Hypothesis testing – z-test, t-test, p-value, confidence intervals. Correlation vs causation.	**Lab 7** Apply descriptive statistics on the Titanic (or any real-world) dataset using Pandas to understand data summarization. **Lab 8** Apply hypothesis testing (t-test and ANOVA) on a real dataset using SciPy to understand statistical significance.
5.	Revision	Revision Labs
6.	Final Exam	

Evaluation Components (EC)				
No	**Name**	**Type**	**Weight**	**Date**
CIE1	Attendance and Class Participation/LMS	Open	10%	-
CIE2	Quiz (MCQ)	Open	20%	
CIE3	Team assignment	Open	20%	TBD
MEE	Module End Exam	Open Book/Lab	50%	Day 6

Instructions:

1. Active participation is expected.
2. Pre-readings, datasets and scripts will be shared through LMS.
3. Lab Manuals will be shared through LMS.

Annexure 1:
Bloom's Taxonomy Level

CO#	Remember (L1)	Understand (L2)	Apply (L3)	Analyse(L4)	Evaluate (L5)	Create(L6)

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CO1				✓		
CO2				✓		
CO3			✓			
CO4			✓			
CO5			✓			
CO6			✓			

Annexure 2: Course Articulation Matrix

CO#/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	M	H	H	H	H	L	L	L	M	L	L	H	H	M
CO2	M	H	H	H	H	L	L	L	M	L	L	H	H	M
CO3	M	H	H	H	H	L	L	L	M	L	L	H	H	M
CO4	M	M	H	H	H	L	L	M	M	L	L	H	H	M
CO5	M	H	H	H	H	L	L	M	M	L	L	H	H	M
CO6	M	H	H	H	H	L	L	M	M	L	L	H	H	H

Legend: Low:1; Medium:2, High:3

Annexure 3: MTech/MSc AI Program Outcomes (POs)

The Semester-Modular MTech/M. Sc. Artificial Intelligence degree Programme is designed to achieve the following objectives. After successful completion of the Programme, the graduates shall be able to:

Sl. No	Program Outcomes (POs)
PO1	Demonstrate in-depth knowledge in Artificial Intelligence and related disciplines, including global perspectives, with the ability to analyze, synthesize, and integrate existing and emerging knowledge for technological advancement.
PO2	Identify, define, and critically analyze complex problems across organizational and technological domains. Apply independent judgment and research methodologies to derive innovative and context-sensitive solutions.
PO3	Design and implement AI-based systems by evaluating multiple solution paths, considering technical feasibility, economic viability, environmental sustainability, public health and safety, and ethical implications.
PO4	Explore unfamiliar problems through systematic literature review, experimentation, and the application of advanced research techniques, leading to the development of novel insights and innovative solutions.
PO5	Select, adapt, and apply state-of-the-art tools, technologies, and AI frameworks for modeling, simulation, analysis, and deployment of intelligent systems, understanding their strengths and limitations.
PO6	Work effectively as an individual and in diverse teams, demonstrating leadership, self-management, and collaborative skills in multidisciplinary and multicultural environments.
PO7	Apply engineering and management principles to plan, execute, and evaluate AI-based projects, while considering economic, financial, and operational constraints in real-world settings.

PO8	Communicate ideas, technical concepts, and research findings clearly and effectively through well-structured documentation, presentations, and discussions with technical and non-technical audiences.
PO9	Recognize the importance of continuous learning and develop the ability to independently pursue upskilling, certifications, research, and knowledge enhancement in the rapidly evolving field of Artificial Intelligence.
PO10	Demonstrate ethical behavior, intellectual honesty, and integrity in research and professional practices, considering the societal and environmental impact of AI systems and contributing to sustainable development.
PO11	Critically evaluate outcomes of personal and professional actions, learn from experiences and failures, and make necessary improvements without relying solely on external feedback.

Annexure 4: MTech/MSc AI Programme Specific Outcomes (PSOs)

After successful completion of the Programme, the graduates shall be able to:

Sl. No	Program Specific Outcomes (POs)
PSO1	Graduates will be able to design and develop intelligent systems using core AI techniques such as machine learning, deep learning, natural language processing, and computer vision to solve real-world multidisciplinary problems.
PSO2	Graduates will demonstrate the ability to build, deploy, and manage AI models in production environments using modern cloud platforms and MLOps tools, integrating industry-recognized certifications.
PSO3	Graduates will possess the skills to identify research problems, conduct systematic investigations, and contribute to the body of knowledge in AI through capstone projects, scholarly publications, and presentations aligned with ethical research practices.
PSO4	Graduates will be prepared for successful careers in industry, academia, or entrepreneurship with the ability to work in teams, engage in lifelong learning, and apply AI solutions responsibly, adhering to ethical and societal norms.

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