



School of Computing

(AMARAVATI, AMRITAPURI, BENGALURU, CHENNAI, COIMBATORE (HQ), FARIDABAD,
KOCHI, MYSURU, NAGERCOIL)

Minor in Artificial Intelligence & Data Science

CURRICULUM 2026

GENERAL INFORMATION

ABBREVIATIONS USED IN THE CURRICULUM

Cat	-	Category
L	-	Lecture
T	-	Tutorial
P	-	Practical
Cr	-	Credits
ENGG	-	Engineering Sciences (including General, Core and Electives)
AIE	-	Computer Science and Engineering - Artificial Intelligence
MAT	-	Mathematics
CGPA	-	Cumulative Grade Point Average

Course Outcome (CO)

Statements that describe what students are expected to know and are able to do at the end of each course. These relate to the skills, knowledge and behaviour that students acquire in their progress through the course.

Program Outcomes (POs)

Program Outcomes are statements that describe what students are expected to know and be able to do upon graduating from the Program. These relate to the skills, knowledge, attitude and behaviour that students acquire through the program. NBA has defined the Program Outcomes for each discipline.

PROGRAM OUTCOMES FOR ENGINEERING

- PO1. Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- PO2. Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- PO3. Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
- PO4. Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
- PO5. Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
- PO6. The Engineer and the World:** Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal, cultural, and environmental issues and the consequent responsibilities relevant to professional engineering practice.
- PO7. Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
- PO8. Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

- PO9. Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
- PO10. Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
- PO11. Life-long learning:** Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Description - PROGRAM SPECIFIC OUTCOMES FOR AI & ML MINOR

This minor program in AI & ML aims at developing fundamental skills pertinent to AI. AICTE has identified AI as an emerging area and insists to train students across different streams of engineering in AI. AI minor will enable the students to apply the AI tools and techniques for solving current technical challenges identified in their major discipline.

After completing the minor in AI & ML, the students will,

- PSO1. Computational Foundations:**
Formulate and analyze data-driven models using statistical reasoning, mathematical optimization, and core algorithmic techniques to solve complex computational challenges
- PSO2. AI System Design and Development:**
Architect, train, and deploy AI models using machine learning paradigms, data pipelines, and state-of-the-art frameworks, including Generative AI and autonomous agentic systems.
- PSO3. AI Applications:**
Adapt and implement AI methodologies to engineer solutions for distinct real-world domains, such as healthcare, robotics, cybersecurity, and cyber-physical smart systems.
- PSO4. Responsible and Scalable AI Systems:**
Deploy production-grade AI systems utilizing scalable computing platforms while ensuring algorithmic fairness, data privacy, and ethical compliance aligned with national technological frameworks.

Prerequisites for pursuing AI & ML Minor

Students who have a CGPA of 7.5 or above at the end of their second semester are eligible to register for this minor. Students interested in mathematics and coding will have an additional advantage.

Curriculum Table

Group A				
Cat.	Code	Title	L T P	Credit
SC	26AIE231M	Fundamentals of Artificial Intelligence	2 0 3	3
SC	26MAT232M	Foundations of Data Science	2 0 3	3
Group B				
Cat.	Code	Title	L T P	Credit
FC	26AIE241M	Python for Artificial Intelligence & Data Science	2 0 3	3
FC	26AIE242M	Mathematics for Artificial Intelligence & Data Science	2 0 3	3
FC	26AIE243M	Applications of Machine Learning	2 0 3	3
Group C				
Cat.	Code	Title	L T P	Credit
SC	26AIE251M	Data Visualisation	2 0 3	3
SC	26AIE252M	Big Data Frameworks	2 0 3	3
SC	26AIE253M	Modern DBMS	2 0 3	3
SC	26AIE254M	Cloud Computing	2 0 3	3
FC	26AIE255M	Advanced Artificial Intelligence	2 0 3	3

26AIE231M	FUNDAMETALS OF ARTIFICIAL INTELLIGENCE	L-T-P-C: 2-0-3-3
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Course Objectives

- To introduce classical AI and rational intelligent agents.
- To introduce techniques for problem solving by search and adversarial games.
- To introduce constraints, logic, and inference techniques
- To introduce planning, acting, and multi-agent systems.
- To introduce knowledge-representation and reasoning.

Course Outcomes

CO	Description
CO1	Analyse different elements of an AI system.
CO2	Apply elementary principles of AI for problem solving and search
CO3	Apply constraints and logic for intelligent systems
CO4	Apply knowledge representation and reasoning for defining intelligent systems

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO															
CO1	3	2	2	2	3	2	2	2	2	-	2	1	2	1	-
CO2	2	2	2	2	3	-	-	2	2	-	2	2	2	2	1
CO3	2	2	2	2	3	-	-	2	2	-	2	2	1	1	-
CO4	3	2	2	2	3	-	-	2	2	2	2	2	2	2	1

Syllabus:

Unit I: Foundations of Artificial Intelligence and Intelligent Search

History and Foundations of Artificial Intelligence, Rational Intelligent Agents, Agents and Environments, Nature of Environments, Structure of Intelligent Agents, Problem Solving using Search, Uninformed Search Strategies, Informed Search Strategies, Heuristic Functions, Adversarial Search, Game Playing, Optimal Decision Making in Games, Alpha-Beta Pruning.

Unit II: Knowledge Representation and Constraint Satisfaction

Constraint Satisfaction Problems (CSPs), Inference in CSPs, Backtracking Search, Knowledge-Based Agents, Propositional Logic, First-Order Logic, Resolution Theorem Proving, Unification, Forward Chaining and Backward Chaining.

Unit III: Planning and Intelligent Systems

Classical Planning, Planning Algorithms, Planning Graphs, Hierarchical Planning, Planning and Acting in Nondeterministic Domains, Multi-Agent Planning, Knowledge Representation, Ontological Engineering, Categories and Objects, Events, Reasoning with Default Information.

Textbooks/ References:

1. Russell, Stuart Jonathan, Norvig, Peter, Davis, Ernest. Artificial Intelligence: A Modern Approach. United Kingdom: Pearson, 2010.
2. Deepak Khemani. A First Course in Artificial Intelligence. McGraw Hill Education (India), 2013.
3. Denis Rothman. Artificial Intelligence by Example, Packt, 2018.

Evaluation Pattern: 70:30

Assessment	Internal / External	Weightage	Suggested Evaluation
Continuous Assessment – Theory (CAT)	Internal	30	Quizzes / Assignments / Case Studies
Continuous Assessment – Lab (CAL)	Internal	20	Lab Evaluations / Mini Projects
Mid-Term Examination	Internal	20	Written Exam (50 Marks, 2 Hours)
End Semester Assessment	External	30	Hybrid Exam / Project

26MAT232M	FOUNDATIONS OF DATA SCIENCE	L-T-P-C: 2-0-3-3
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Course Objectives

- To teach primary tools for exploration, visualizations and descriptive statistics, for prediction are machine learning and optimization, and for inference are statistical tests and models.
- To make students learn to ask appropriate questions about their data and correctly interpret the answers provided by inferential and computational tools.

Course Outcomes

CO	Description
CO1	Understand the statistical foundations of data science.
CO2	Apply pre-processing techniques over raw data to enable further analysis.
CO3	Conduct exploratory data analysis and create insightful visualizations to identify patterns.
CO4	Identify machine learning algorithms for regression/classification tasks and to get into insights.
CO5	Analyze the degree of certainty of predictions using statistical tests and models.

CO-PO Mapping

CO / PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	1	–	–	–	–	–	–	–	–	–	–	2	2	1	–
CO2	1	1	–	1	3	–	–	–	–	–	–	2	2	2	1
CO3	3	1	1	2	3	–	–	–	–	–	–	2	2	2	1
CO4	3	1	1	2	2	–	–	2	–	–	–	2	2	3	2
CO5	3	3	1	3	2	–	–	–	–	–	–	2	2	3	2

Syllabus

Unit I: Foundations of Data Science and Exploratory Data Analysis

Introduction to Data Science, Causality and Experiments, Data Preprocessing, Data Cleaning, Data Reduction, Data Transformation, Exploratory Data Analysis using Python, Visualization of Categorical and Numerical Data, Summary Statistics, Random Variables, Probability Distributions, Discrete and Continuous Distributions, Sampling Concepts, Central Limit Theorem and its Applications.

Unit II: Statistical Inference and Hypothesis Testing

Descriptive Statistics, Measures of Central Tendency and Dispersion, Variance, Covariance, Five-Point Summary, Bayes' Theorem, Statistical Inference, P-values, Hypothesis Testing, Model Assessment, Decision Making under Uncertainty, Comparing Samples, Chi-Square Test and A/B Testing.

Unit III: Regression Analysis and Data Visualization

Linear Regression, Regression Model Building, Least Squares Method, Prediction using Regression Models, Model Assumptions, Data Transformation, Web Scraping, Introduction to Data Visualization Tools, Tableau and Power BI.

Textbook(s)

1. Ani Adhikari and John DeNero, David Wagner. "Computational and Inferential Thinking: The Foundations of Data Science", 2nd Edition, e-book 2021.
<https://inferentialthinking.com/chapters/intro.html>.

Reference(s)

1. William Navidi, "Statistics for Engineers and Scientists", Fifth Edition, McGraw Hill, 2020.
2. Galit Shmueli, Peter C. Bruce, Inbal Yahav, Nitin R. Patel, Kenneth C. Lichtendahl Jr. "Data Mining for Business Analytics: Concepts, Techniques and Applications in R", Wiley India, 2018.
3. Rachel Schutt & Cathy O'Neil, "Doing Data Science", O' Reilly, First Edition, 2013. Joel Grus, "Data Science from Scratch", Second edition, O'Reilly Media, Inc. 2019.
4. Wes McKinney, "Python for Data Analysis", Wes McKinney, Third Edition, O'Reilly, 2022.

Evaluation Pattern: 70:30

Assessment	Internal / External	Weightage	Suggested Evaluation
Continuous Assessment – Theory (CAT)	Internal	10	Quizzes / Assignments / Case Studies
Continuous Assessment – Lab (CAL)	Internal	40	Lab Evaluations / Mini Projects
Mid-Term Examination	Internal	20	Written Exam (50 Marks, 2 Hours)
End Semester Assessment	External	30	Hybrid Exam / Project

26AIE241M	PYTHON FOR ARTIFICIAL INTELLIGENCE & DATA SCIENCE	L-T-P-C: 2-0-3-3
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Course Objectives

- To introduce Python programming fundamentals for Artificial Intelligence and Data Science applications.
- To develop computational thinking and problem-solving skills using Python.
- To familiarize students with Python packages used for data analysis, visualization, and AI applications.
- To enable students to develop simple AI and Data Science applications using Python.

Course Outcomes

CO	Description
CO1	Develop Python programs using programming constructs, functions, modules, and file handling techniques.
CO2	Apply Python libraries for numerical computing, data manipulation, and visualization.
CO3	Perform exploratory data analysis and data preprocessing using Python packages.
CO4	Develop simple AI and Data Science applications using Python libraries and development tools.

CO-PO Mapping

CO / PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	3	2	2	2	2	2	–	3	2	3	2
CO2	2	2	2	2	3	–	–	–	2	2	–	3	2	3	2
CO3	2	2	2	2	3	–	–	–	2	2	–	3	2	3	2
CO4	3	2	2	2	3	–	–	–	2	2	2	3	2	3	2

Syllabus

Unit I: Python Programming Fundamentals

Introduction to Python, Installation and Development Environment, Variables and Data Types, Operators and Expressions, Input and Output, Conditional Statements, Iterative Statements, Functions, Modules and Packages, Exception Handling, File Handling and Basic Object-Oriented Programming Concepts.

Unit II: Python for Data Science

Python Data Structures, Lists, Tuples, Sets, Dictionaries, String Manipulation, Introduction to NumPy, Arrays and Matrix Operations, Introduction to Pandas, Series and DataFrames, Data Import and Export, Data Cleaning, Data Manipulation, Data Preprocessing and Exploratory Data Analysis.

Unit III: Data Visualization and AI Applications

Data Visualization using Matplotlib and Seaborn, Introduction to Scikit-Learn, Introduction to Jupyter Notebook and Google Colab, Overview of Artificial Intelligence and Data Science, AI Applications across Engineering Domains, Introduction to OpenCV for Image Processing, Introduction to TensorFlow Ecosystem, Simple AI Applications using Python and Mini Project.

Text Book(s)

1. Eric Matthes, **Python Crash Course**, 3rd Edition, No Starch Press, 2023.
2. Wes McKinney, **Python for Data Analysis**, 3rd Edition, O'Reilly Media, 2022.

Reference(s)

1. Jake VanderPlas, **Python Data Science Handbook**, O'Reilly Media.
2. Allen B. Downey, **Think Python: How to Think Like a Computer Scientist**, 2nd Edition.
3. Andreas C. Müller and Sarah Guido, **Introduction to Machine Learning with Python**, O'Reilly Media.
4. Aurélien Géron, **Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow**, 3rd Edition, O'Reilly Media.

Evaluation Pattern: 70:30

Assessment	Internal / External	Weightage	Suggested Evaluation
Continuous Assessment – Theory (CAT)	Internal	20	Quizzes / Assignments / Case Studies
Continuous Assessment – Lab (CAL)	Internal	30	Lab Evaluations / Mini Projects
Mid-Term Examination	Internal	20	Written Exam (50 Marks, 2 Hours)
End Semester Assessment	External	30	Hybrid Exam / Project

	& DATA SCIENCE	
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Course Objectives

- To introduce the mathematical foundations required for Artificial Intelligence and Data Science.
- To develop problem-solving skills using concepts from linear algebra, calculus, probability, and statistics.
- To familiarize students with mathematical techniques used in machine learning and data analysis.
- To enable students to apply mathematical concepts for modelling and solving AI-driven problems.

Course Outcomes

CO	Description
CO1	Apply concepts of linear algebra and matrix computations to represent and analyze data used in AI and Data Science.
CO2	Apply differential calculus and optimization techniques to formulate and solve machine learning problems.
CO3	Analyze uncertainty in data using probability and statistical techniques.
CO4	Apply mathematical foundations to understand and solve fundamental Artificial Intelligence and Data Science problems.

CO-PO Mapping

CO / PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	3	2	2	2	2	2	–	3	2	3	2
CO2	2	2	2	2	3	–	–	–	2	2	–	3	2	3	2
CO3	2	2	2	2	3	–	–	–	2	2	–	3	2	3	2
CO4	3	2	2	2	3	–	–	–	2	2	2	3	2	3	2

Syllabus

Unit I: Linear Algebra for Artificial Intelligence

Vectors and Matrices, Matrix Operations, Systems of Linear Equations, Rank of a Matrix, Vector Spaces, Eigenvalues and Eigenvectors, Singular Value Decomposition (SVD), Applications in Data Representation and Dimensionality Reduction.

Unit II: Calculus and Optimization

Partial Differentiation, Gradient, Jacobian, Convex and Non-convex Functions, Optimization Problems, Gradient Descent, Stochastic Gradient Descent, Loss Functions and Applications in Machine Learning.

Unit III: Probability, Statistics and Mathematical Foundations

Random Variables, Probability Distributions, Expectation, Variance, Covariance, Correlation, Bayes Theorem, Sampling Techniques, Statistical Estimation, Hypothesis Testing, Linear

Regression Mathematics, Principal Component Analysis (Concept), Mathematical Foundations of K-Means Clustering and Mathematical Modelling for AI Applications.

Text Book(s)

1. Gilbert Strang, **Linear Algebra and Learning from Data**, Wellesley-Cambridge Press, 2019.
2. Stephen Boyd and Lieven Vandenberghe, **Introduction to Applied Linear Algebra: Vectors, Matrices, and Least Squares**, Cambridge University Press, 2018.
3. Bradley Efron and Trevor Hastie, **Computer Age Statistical Inference**, Cambridge University Press, 2021.

Reference(s)

1. Stephen Boyd and Lieven Vandenberghe, **Convex Optimization**, Cambridge University Press, 2018.
2. Kevin P. Murphy, **Probabilistic Machine Learning: An Introduction**, MIT Press, 2022.
3. Christopher M. Bishop and Hugh Bishop, **Deep Learning: Foundations and Concepts**, Springer, 2024.
4. Gareth James, Daniela Witten, Trevor Hastie and Robert Tibshirani, **An Introduction to Statistical Learning with Applications in Python**, Springer, 2023.

Evaluation Pattern: 70:30

Assessment	Internal / External	Weightage	Suggested Evaluation
Continuous Assessment – Theory (CAT)	Internal	20	Quizzes / Assignments / Case Studies
Continuous Assessment – Lab (CAL)	Internal	30	Lab Evaluations / Mini Projects
Mid-Term Examination	Internal	20	Written Exam (50 Marks, 2 Hours)
End Semester Assessment	External	30	Hybrid Exam / Project

26AIE243M	APPLICATIONS OF MACHINE LEARNING	L-T-P-C: 2-0-3-3
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Course Objectives

Course Objectives

- To familiarize students with the end-to-end Machine Learning workflow for solving real-world problems.
- To develop the ability to build, evaluate, and optimize Machine Learning models using modern tools and frameworks.
- To expose students to specialized Machine Learning applications across healthcare, agriculture, cyber-physical systems, and security.
- To introduce responsible AI practices, model deployment concepts, and domain-specific engineering trends in Machine Learning.

Course Outcomes

CO	Description
CO1	Apply the Machine Learning workflow, including data preprocessing, feature engineering, model selection, and validation, to solve domain-specific problems.
CO2	Develop and evaluate core supervised, unsupervised and reinforcement Machine Learning models using appropriate algorithms, tools, and performance metrics.
CO3	Design and implement intelligent applications using specialized Machine Learning techniques for healthcare and precision agriculture domains with appropriate data modalities.
CO4	Engineer Machine Learning solutions for cyber-physical systems and security infrastructures while ensuring explainability, fairness, and ethical deployment.

CO-PO Mapping

CO / PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	3	2	2	2	2	–	2	2	2	1	1
CO2	2	3	2	2	3	–	–	2	2	–	2	2	3	2	2
CO3	2	2	3	2	3	2	2	2	2	2	2	2	2	3	3
CO4	2	2	2	2	2	2	2	3	2	2	2	1	2	3	3

Syllabus

Unit I: Introduction to Machine Learning

Review of Artificial Intelligence, Machine Learning and Deep Learning, Types of Machine Learning: Supervised Learning, Unsupervised Learning and Reinforcement Learning, Core Machine Learning Workflow, Data Collection, Data Preprocessing, Feature Engineering, Feature Selection, Training, Cross Validation and Testing, Core Machine Learning Algorithms, Linear Regression, Logistic Regression, Decision Trees, Random Forests, K-Nearest Neighbours and K-Means Clustering, Model Evaluation Metrics, Accuracy, Precision, Recall, F1-Score, ROC-AUC and Mean Squared Error, Python Libraries for Machine Learning, Scikit-Learn, NumPy and Pandas.

Unit II: Machine Learning Models

Healthcare Applications, Patient Risk Stratification using Electronic Health Records (Supervised Learning with Tabular and Time-Series Data), Medical Image Analysis for

Disease Detection (Computer Vision with Medical Images), Clinical Document Classification and Summarization (Natural Language Processing with Text Data), Health Monitoring using Wearable Devices (Time-Series Analysis with Biosensor Data), Agriculture Applications, Crop Yield Prediction and Soil Health Assessment (Regression with Tabular and Spatial Data), Plant Disease Detection using Drone Imagery (Computer Vision with Image Data), Smart Irrigation using Internet of Things Sensors (Time-Series Analysis with Sensor Data), Autonomous Harvesting and Navigation (Reinforcement Learning with Multimodal Data).

Unit III: Responsible AI and Machine Learning Applications

Cyber-Physical Systems and Smart Infrastructure, Predictive Maintenance and Anomaly Detection (Unsupervised Learning with Sensor Data), Autonomous Vehicle Navigation (Deep Reinforcement Learning with Multi-Sensor Data), Smart Grid Load Forecasting (Time-Series Forecasting with Energy Data), Security Applications, Network Intrusion Detection and DDoS Detection (Classification with Network Traffic Data), Financial Fraud Detection (Supervised Learning with Transaction Data), Malware Classification (Supervised Learning with Executable Data), AutoML and No-Code Machine Learning Tools, Explainable AI, Bias, Fairness and Ethical AI, Edge AI, Generative AI for Synthetic Data Augmentation and Mini Project.

Text Books

1. Aurélien Géron, *Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow*, 3rd Edition, O'Reilly, 2023.
2. Andreas C. Müller and Sarah Guido, *Introduction to Machine Learning with Python*, O'Reilly Media, 2017.
3. Kevin P. Murphy, *Probabilistic Machine Learning: An Introduction*, MIT Press, 2022.

References

1. Ethem Alpaydin, *Introduction to Machine Learning*, 5th Edition, MIT Press, 2021.
2. Christopher M. Bishop and Hugh Bishop, *Deep Learning: Foundations and Concepts*, Springer, 2024.
3. Foster Provost and Tom Fawcett, *Data Science for Business*, 2nd Edition, O'Reilly Media.
4. Géron, Aurélien, *AI and Machine Learning for Coders*, O'Reilly Media.

Evaluation Pattern: 70:30

Assessment	Internal / External	Weightage	Suggested Evaluation
Continuous Assessment – Theory (CAT)	Internal	30	Quizzes / Assignments / Case Studies
Continuous Assessment – Lab (CAL)	Internal	20	Lab Evaluations / Mini Projects
Mid-Term Examination	Internal	20	Written Exam (50 Marks, 2 Hours)
End Semester Assessment	External	30	Hybrid Exam / Project
26AIE251M	DATA VISUALIZATION		L-T-P-C: 2-0-3-3

Course Objectives

- To provide knowledge on visualization design principles and deciding the type of visualization chart to choose for the given datasets.
- To teach on creating simple to advanced chart types using python modules and libraries.
- To help students explore, visualize and analyse various types of data sets such as geospatial and multimodal data.
- To help students work on visualization tools and enable them to understand the visual analytics such as dashboards and storytelling with a hands-on experience on tableau and R.

Course Outcomes

CO	Description
CO1	Understand the importance of Data Visualization and learn to create basic charts by applying visualization design principles.
CO2	Learn to create advanced visualization charts and analysis.
CO3	Explore and analyse geospatial and multimodal data.
CO4	Learn to build interactive/animated and ethically correct dashboards, construct data stories, and communicate important trends/patterns in the data sets.

CO-PO Mapping

CO / PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	3	2	–	1	–	–	–	–	–	–	–	2	3	2	1
CO2	2	3	–	2	–	–	–	–	–	–	–	2	3	2	1
CO3	2	2	–	3	–	–	–	–	–	–	–	2	3	3	2
CO4	3	2	–	2	–	–	–	3	–	–	–	2	3	3	3

Syllabus

Unit I: Fundamentals of Data Visualization

Introduction to Data Visualization, Principles of Data Visualization, Storytelling with Data, Data Visualization Tools, Matplotlib, Displaying Plots, Plotting from Scripts, Line Colors and Styles, Axes Limits, Plot Labels, Scatter Plots, Error Visualization, Density and Contour Plots, Histograms, Binning and Kernel Density Estimation, Legends, Colorbars, Colormap Selection, Sequential, Divergent and Qualitative Colormaps, Color Limits and Extensions, Manifold Embedding of Handwritten Digit Pixels, Multiple Subplots, Text and Annotations, Transforms and Text Positioning, Arrows and Annotations, Tick Customization, Stylesheets (ggplot), Three-Dimensional Plotting, Contour Plots, Wireframes, Surface Plots and Surface Triangulations.

Unit II: Statistical and Geospatial Data Visualization

Geographic Data Visualization using Basemap, Map Projections, Cylindrical, Perspective and Conic Projections, Map Backgrounds, Plotting Data on Maps, Data Visualization using Seaborn, Pair Plots, Factor Plots, Histograms as Factor Plots and Violin Plots.

Unit III: Advanced Visualization and Dashboard Design

Advanced Visualizations using Tableau, Choropleth Maps, Waffle Charts, Dashboards,

Dashboard Development using Tableau and Plotly, Data Visualization using R, Data Ethics and Visualization Ethics.

Textbook(s)

1. Jake VanderPlas, "Python Data Science Handbook - Essential Tools for Working with Data", O'Reilly, 2nd Edition, 2022. Wes McKinney, "Python for Data Analysis", O'Reilly, 2nd Edition, 2023.
2. Tamara Munzner, "Visualization Analysis and Design", A K Peters Visualization Series, CRC Press, 2014.

Reference(s)

1. Scott Murray, "Interactive Data Visualization for the Web", O'Reilly, 2013.
2. Alberto Cairo, "The Functional Art: An Introduction to Information Graphics and Visualization", New Riders, 2012.
3. Cole Nussbaumer Knaflic, "Storytelling with Data: A Data Visualization Guide for Business Professionals", Wiley, 2015.
4. Nathan Yau, "Visualize This: The Flowing Data Guide to Design, Visualization and Statistics", John Wiley & Sons, 2011.

Evaluation Pattern: 70:30

Assessment	Internal / External	Weightage	Suggested Evaluation
Continuous Assessment – Theory (CAT)	Internal	10	Quizzes / Assignments / Case Studies
Continuous Assessment – Lab (CAL)	Internal	40	Lab Evaluations / Mini Projects
Mid-Term Examination	Internal	20	Written Exam (50 Marks, 2 Hours)
End Semester Assessment	External	30	Hybrid Exam / Project

26AIE252M	BIG DATA FRAMEWORKS	L-T-P-C: 2-0-3-3
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Course Objectives

- To understand how to use Big data frameworks and APIs.
- To conceptualize data analysis.
- To learn about various data processing and pipelining strategies.
- To understand and visualize map-reduce computing paradigm.
- To learn the intricate and distributed working of Big Data clusters
- To train and impart the skills required for managing and balancing large data clusters

Course Outcomes (CO)

CO	Description
CO1	Solve problems through map-reduce approach
CO2	Implement data analytics solutions using general data pipelining
CO3	Apply scaling up machine learning techniques and associated computing techniques and technologies.
CO4	Identify the characteristics of datasets and compare the trivial data and big data for various applications.

CO-PO Mapping

CO / PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	2	3	–	–	–	–	–	–	2	2	2	1
CO2	2	3	2	2	3	–	–	–	–	–	–	2	2	3	2
CO3	2	2	3	3	3	–	–	–	–	–	–	2	2	3	3
CO4	2	2	2	2	3	–	–	2	–	–	2	2	2	3	3

Syllabus

Unit I: Introduction to Big Data and Distributed Computing

Introduction to Big Data, Characteristics of Big Data, Big Data Analytics, Distributed Computing Concepts, Hadoop Ecosystem, Hadoop Distributed File System (HDFS), Hadoop Architecture, MapReduce Programming Model, Input and Output Formats, MapReduce Applications.

Unit II: Big Data Processing Frameworks

Apache Spark Architecture, Resilient Distributed Datasets (RDDs), Spark Transformations and Actions, Spark SQL, DataFrames, Spark Streaming (Introduction), NoSQL Databases, HBase, Introduction to Apache Hive and Pig, Data Processing and Querying.

Unit III: Big Data Analytics and Applications

Big Data Analytics Pipeline, Data Ingestion, Data Processing, Data Visualization, Cluster Management, Cloud-based Big Data Platforms, Big Data Applications in Healthcare, Finance, Smart Cities and IoT, Security and Privacy in Big Data, Mini Project.

Text Books / Reference Books

1. Learning Spark: Lightning-Fast Big Data Analysis', Holden Karau , Andy Konwinski, Patrick Wendell and Matei Zaharia, O'Reilly; 1st edition , 2015
2. 'Programming in Scala: A Comprehensive Step-by-Step Guide', Martin Odersky, Lex Spoon and Bill Venners, Artima Inc; Version ed. edition , 2008
3. 'High Performance Spark: Best Practices for Scaling and Optimizing Apache Spark', Holden Karau, Rachel Warren, O'Reilly; 1st edition, 2017
4. 'Scala for the Impatient', Cay S. Horstmann, Addison-Wesley; 2nd edition, 2017
5. "Mongo DB in Action", Kyle Banker, Manning Publications; 2nd edition, 2016
6. "MongoDB: The Definitive Guide", Shannon Bradshaw, Eoin Brazil, Kristina Chodorow, O'Reilly; 3rd edition, 2019

Evaluation Pattern: 70: 30

Assessment	Internal / External	Weightage	Suggested Evaluation
Continuous Assessment – Theory (CAT)	Internal	10	Quizzes / Assignments / Case Studies
Continuous Assessment – Lab (CAL)	Internal	40	Lab Evaluations / Mini Projects
Mid-Term Examination	Internal	20	Written Exam (50 Marks, 2 Hours)
End Semester Assessment	External	30	Hybrid Exam / Project

26AIE253M	MODERN DBMS	L-T-P-C: 2-0-3-3
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Course Objectives

- To understand the design, querying, storage management and transaction processing of SQL and NoSQL databases.
- To learn advanced database design principles – graph databases, columnar databases and document databases.

Course Outcomes

CO	Description
CO1	Analyze the design of RDBMS and its internals
CO2	Apply algorithms for query processing and optimization
CO3	Apply transaction processing and concurrency control techniques for real-world applications.
CO4	Apply the design of Object relational, Graph and NoSQL databases for real-world applications

CO-PO Mapping

CO / PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	2	3	–	–	–	–	–	–	2	3	2	1
CO2	2	3	2	2	3	–	–	–	–	–	–	2	3	2	2
CO3	2	2	3	3	3	–	–	–	–	–	–	2	3	3	2
CO4	2	2	2	2	3	–	–	2	–	–	2	2	3	3	3

Syllabus

Unit I: Database Fundamentals and Relational Databases

Introduction to Database Management Systems, Database Architecture, Data Models, Entity-Relationship Model, Relational Model, Relational Algebra, Structured Query Language (SQL), Database Design, Functional Dependencies, Normalization (up to Third Normal Form), Transactions and Concurrency Control.

Unit II: NoSQL and Distributed Databases

Introduction to NoSQL Databases, Key-Value Stores, Document Databases, Column-Family Databases and Graph Databases, CAP Theorem, Distributed Databases, Data Partitioning, Replication, Consistency Models, Introduction to MongoDB, CRUD Operations and Aggregation Framework.

Unit III: Modern Database Applications

Cloud Databases, Database Security and Privacy, Database Backup and Recovery, Database Connectivity using Python, Databases for Big Data and Artificial Intelligence Applications, Data Warehousing, Introduction to Data Lakes, Real-Time Data Management and Mini Project.

Text Books/References

1. Ramesh Elmasri and Shamkant B Navathe, "Fundamentals of Database Systems", Fifth Edition, Pearson Education India, 2008.
2. Silberschatz A, Korth H F and Sudharshan S, "Database System Concepts", Sixth Edition, Tata McGraw-Hill Publishing Company Limited, 2010.
3. Niall O'Higgins, "MongoDB and Python", O'reilly, 2011.
4. Hector Garcia-Molina, Jeff Ullman and Jennifer Widom, "Database Systems: The Complete Book", Pearson, 2011.
5. Raghu Ramakrishnan and Johannas Gehrke, "Database Management Systems", Third Edition, McGraw-Hill, 2003.
6. Andreas Meier, Michael Kaufmann, "SQL & NoSQL Databases: Models, Languages, Consistency Options and Architectures for Big Data Management", Springer Verlag 2019.

Evaluation Pattern: 70:30

Assessment	Internal / External	Weightage	Suggested Evaluation
Continuous Assessment – Theory (CAT)	Internal	10	Quizzes / Assignments / Case Studies
Continuous Assessment – Lab (CAL)	Internal	40	Lab Evaluations / Mini Projects
Mid-Term Examination	Internal	20	Written Exam (50 Marks, 2 Hours)
End Semester Assessment	External	30	Hybrid Exam / Project

26AIE254M	CLOUD COMPUTING	L-T-P-C: 2-0-3-3
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Course Objectives

- This course introduces the basic principles of cloud computing, cloud native application development and deployment, containerization principles, micro-services and application scaling.
- This course will also equip the students to understand major industry players in the public cloud domain for application development and deployment.

Course Outcomes

CO	Description
CO1	Demonstrate the functionalities of cloud computing.
CO2	Apply cloud native application development for containerization and container orchestration.
CO3	Analyze different types of cloud services – Delivery models, Deployment models.
CO4	Implement different solution approaches in Cloud – containers in public cloud, setting up private cloud and convert monolithic applications to containers.

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO															
CO1	3	1	1	-	-	-	-	-	-	1	-	3	1	-	-
CO2	3	2	2	2	3	2	2	2	2	2	2	1	2	2	1
CO3	3	2	2	2	3	2	2	1	-	2	-	2	1	-	-
CO4	3	2	2	2	3	2	2	2	2	2	2	1	3	2	1

Syllabus

Unit I

Distributed Computing Taxonomy – Cluster, Grid, P2P, Utility, Cloud, Edge, Fog computing paradigms; Introduction to Cloud Computing – Cloud delivery models (XaaS), Cloud deployment models (Private, Public, Hybrid); Characteristics of Cloud, Major use cases of Cloud; disadvantages and best practices; Major public cloud players in the market; Security Issues and Challenges; Cloud Native application development – Introduction to JavaScript Cloud native application development

Unit II

Public Cloud – Using public cloud for infrastructure management (compute and storage services), Web application deployment using public cloud services, and Deploying container images in public cloud, Overview of cognitive services, Case study on architecting cloud-based solutions for a chosen scenario.

Unit III

Virtualization – Basics, Cloud vs Virtualization, Types of virtualizations, Hypervisor types; Containers – Introduction to dockers and containers, containerization vs virtualization, docker architecture, Use cases, Learn how to build container images, Operations on container images; Kubernetes – Need for orchestration, container orchestration methods, Introduction to Kubernetes, Kubernetes architecture, using YAML file, Running Kubernetes via minikube.

Textbooks/References

1. Rajkumar Buyya et.al. Mastering cloud computing, McGraw Hill Education;2013.
2. Matthias K, Kane SP. Docker: Up & Running: Shipping Reliable Containers in Production. " O'Reilly Media, Inc."; 2018.

3. Gift, Noah. Pragmatic AI: An Introduction to Cloud-based Machine Learning. Addison-Wesley Professional, 2018
4. Kocher PS. Microservices and Containers. Addison-Wesley Professional; 2018.
5. Sarkar A, Shah A. Learning AWS: Design, build, and deploy responsive applications using AWS Cloud components. Packt Publishing Ltd; 2018.
6. Menga J. Docker on Amazon Web Services: Build, deploy, and manage your container applications at scale. Packt Publishing Ltd; 2018.
7. Bentley W. OpenStack Administration with Ansible 2. Packt Publishing Ltd; 2016

Evaluation Pattern: 70:30

Assessment	Internal / External	Weightage	Suggested Evaluation
Continuous Assessment – Theory (CAT)	Internal	10	Quizzes / Assignments / Case Studies
Continuous Assessment – Lab (CAL)	Internal	40	Lab Evaluations / Mini Projects
Mid-Term Examination	Internal	20	Written Exam (50 Marks, 2 Hours)
End Semester Assessment	External	30	Hybrid Exam / Project

26AIE255M	ADVANCED ARTIFICIAL INTELLIGENCE	L-T-P-C: 2-0-3-3
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Course Objectives

- To expose students to advanced Artificial Intelligence techniques and modern AI paradigms.
- To develop the ability to build AI-enabled solutions using contemporary AI frameworks and pre-trained models.
- To familiarize students with AI applications across multidisciplinary engineering domains.
- To introduce responsible AI practices, trustworthy AI, and emerging AI technologies.

Course Outcomes

CO	Description
CO1	Apply advanced AI techniques and workflows to develop intelligent solutions for domain-specific problems.
CO2	Develop AI-enabled applications using pre-trained models, foundation models, and modern AI frameworks.
CO3	Analyze AI solutions using explainability, evaluation metrics, and deployment strategies for real-world applications.
CO4	Evaluate AI systems with respect to ethics, fairness, security, sustainability, and emerging AI technologies.

CO-PO Mapping

CO / PO- PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	3	2	2	2	2	–	2	2	2	2	1
CO2	2	2	3	2	3	–	–	2	2	2	2	2	3	3	2
CO3	2	3	2	3	3	2	2	2	2	2	2	2	3	3	3
CO4	2	2	2	2	2	2	2	3	2	2	3	1	2	3	3

Syllabus

Unit I: Machine Learning and Deep Learning Foundations

Review of Machine Learning, Artificial Neural Networks, Deep Neural Networks, Convolutional Neural Networks, Recurrent Neural Networks, Transfer Learning, Model Training and Evaluation, Introduction to Generative Artificial Intelligence.

Unit II: Intelligent Systems and Large Language Models

Natural Language Processing, Computer Vision, Transformers, Generative Artificial Intelligence, Generative Adversarial Networks (GANs), Variational Autoencoders (VAEs) (Overview), Diffusion Models (Overview), Large Language Models (LLMs), Prompt Engineering, Retrieval-Augmented Generation (RAG), AI Agents, Multi-Agent Systems and AI Development Frameworks.

Unit III: Responsible AI and Emerging Applications

Explainable Artificial Intelligence, Fairness, Bias and Ethical AI, Privacy and Security in AI, AI Governance, Edge AI, AI Applications in Healthcare, Agriculture, Manufacturing, Finance and Smart Cities, Emerging Trends in Artificial Intelligence, Mini Project.

Textbooks

1. Christopher M. Bishop and Hugh Bishop, Deep Learning: Foundations and Concepts, Springer, 2024.
2. Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow, 3rd Edition, O'Reilly Media, 2023.

References

1. Kevin P. Murphy, Probabilistic Machine Learning: An Introduction, MIT Press, 2022.
2. Russell, S. and Norvig, P., Artificial Intelligence: A Modern Approach, 4th Edition, Pearson, 2021.
3. Foster Provost and Tom Fawcett, Data Science for Business, 2nd Edition, O'Reilly Media, 2023.
4. Ian Goodfellow, Yoshua Bengio, and Aaron Courville, Deep Learning, MIT Press.

Evaluation Pattern: 70:30

Assessment	Internal / External	Weightage	Suggested Evaluation
Continuous Assessment – Theory (CAT)	Internal	10	Quizzes / Assignments / Case Studies
Continuous Assessment – Lab (CAL)	Internal	40	Lab Evaluations / Mini Projects
Mid-Term Examination	Internal	20	Written Exam (50 Marks, 2 Hours)
End Semester Assessment	External	30	Hybrid Exam / Project