



University of Kalyani

Department of Library and Information Science

Kalyani – 741235; West Bengal

Master of Science in Artificial Intelligence and Data Science (M.Sc. in AI & DS)

CURRICULUM

on the basis of

National Education Policy, 2020 (NEP 2020)

With effect from 2026-2027 academic session

Approved in the PGBOS meeting held on 07.07.2026

Graduate Attributes
(based on section 6.0 of UGC-C&CFPP)

1. **Advanced Disciplinary Knowledge** – Demonstrate comprehensive knowledge of core and emerging areas in artificial intelligence, data science, machine learning, statistics, and computing, with the ability to seamlessly integrate theory and practice.
2. **Research Competency** – Formulate research problems, design experiments, and conduct independent research using appropriate methodologies, tools, and ethical standards in AI and data science.
3. **Digital and Technological Fluency** – Deploy, develop, and evaluate modern computational tools, programming languages, AI frameworks, and cloud data platforms to build scalable, intelligent systems.
4. **Critical Thinking and Problem-Solving:** Apply analytical, statistical, and computational thinking to model, analyze, and solve complex, real-world problems using data-driven approaches.
5. **Data Handling and Analytical Skills:** Demonstrate proficiency in data acquisition, preprocessing, feature engineering, visualization, and interpretation across diverse, structured, and unstructured data streams.
6. **Interdisciplinary Awareness:** Integrate knowledge from computer science, mathematics, statistics, domain-specific fields, and Indian Knowledge Systems (IKS) to develop context-aware AI and data solutions.
7. **Communication Skills:** Communicate complex technical concepts, data insights, and research findings effectively through technical documentation, data visualizations, written reports, and oral presentations.
8. **Teamwork and Leadership:** Collaborate effectively in multidisciplinary environments and demonstrate leadership, project management, and coordination skills in AI and data science initiatives.
9. **Ethical and Social Responsibility:** Apply ethical principles in AI and data governance, prioritizing fairness, accountability, transparency (FAT), algorithmic bias mitigation, data privacy, and responsible technology deployment.
10. **Societal and Community Engagement:** Deploy AI and data science solutions to address community challenges, promote digital inclusion, and contribute to sustainable, socially beneficial technological development.
11. **Employability and Professionalism:** Demonstrate industry-ready competencies through practical laboratory work, real-world projects, internships, and exposure to contemporary MLOps, software practices, and enterprise data tools.
12. **Lifelong Learning and Innovation:** Exhibit adaptability, curiosity, creativity, and a commitment to continuous learning to respond effectively to rapid advancements in AI, data science, and emerging technologies.

Programme Learning Outcomes (PLOs)
(aligned with NHEQF Level 6.5)

- PLO1. Demonstrate advanced understanding of the theoretical foundations of artificial intelligence, data science, mathematics, statistics, and computing, and their relevance in solving real-world problems.
- PLO2. Apply algorithms, data structures, statistical methods, and machine learning techniques to analyze structured and unstructured data effectively.
- PLO3. Design, develop, and implement intelligent systems using modern tools, programming languages, and AI frameworks for diverse applications.
- PLO4. Perform data acquisition, preprocessing, visualization, and interpretation using appropriate analytical and computational techniques.
- PLO5. Develop and evaluate predictive, descriptive, and prescriptive models for decision-making across domains such as healthcare, finance, education, and industry.
- PLO6. Utilize big data technologies and scalable computing platforms to manage and process large and complex datasets.
- PLO7. Apply advanced techniques in machine learning, deep learning, and generative AI to build innovative and efficient solutions.
- PLO8. Conduct research using appropriate methodologies, tools, and experimental design, and communicate findings through reports, publications, and presentations.
- PLO9. Demonstrate proficiency in interdisciplinary integration by applying AI and data science techniques in domains such as social sciences, natural sciences, and engineering.
- PLO10. Recognize and apply ethical, legal, and societal considerations, including data privacy, bias, fairness, and responsible AI practices.
- PLO11. Engage with Indian Knowledge Systems (IKS) and global perspectives to contextualize AI and data science applications in cultural, societal, and policy frameworks.
- PLO12. Exhibit professional skills, including communication, teamwork, leadership, and entrepreneurship, and demonstrate readiness for employment, higher studies, and lifelong learning in the evolving AI and data science landscape.

M.Sc. in Artificial Intelligence and Data Science (M.Sc. in AI & DS)

Overview

Integrated Two Academic Sessions :: Four Semester Course :: NEP-2020 based Curriculum Framework (With effect from 2026-2027 academic session)

Eligibility: B.Sc. Degree (3-year UG or 4-year UG) or its equivalent (B.E., B. Tech., MBA, BBA, BCA etc.) from any recognized University with Mathematics as a subject/paper in all levels of Education from 10+2 or equivalent.

Intake: Forty **(40)** [May change from time to time based on University notification]

Academic Calendar: As per the University Academic calendar.

Admission procedure: As per the University notification.

Course Structure:

- M.Sc. in AI &DS programme is in the **Level 6.5** of NHEQF-2023 and follows NCrF-2023 and UGC-C&CFPP-2024.
- M.Sc. in AI &DS curriculum consists of **88 credits** distributed in **25 courses** in **2 academic sessions** and **4 semesters**.
- Each student is required to complete a total of **84 credits** from this curriculum, including **4 credits** from Interdisciplinary Courses (IDS) offered by various departments of University of Kalyani, including the Department of Computer Science and Engineering.
- **50 credits** are meant for **Major Courses**, **16 credits** for **discipline-specific Minor/Skill-enhanced** courses, **4 credits** for IDS course, **4 credits** for IKS, **10 credits** for guided research project/dissertation, **4 credits** for Grand Viva. Course includes **2 non-credit mandatory value-added courses**.
- PGBOS in Computer Science and Engineering will determine **related/equivalent online courses** (SWAYAM/NPTEL/e-PG-Pathshala etc) and a total of 20% credits of the programme (particularly VAC, SEC, IKS, Minor and Elective courses) may be earned by a student in virtual learning mode.
- Intake capacity for the IDS Course (AIDS-IDS-451) will be determined by the department in every session.

Core Objective: To equip learners with strong foundational knowledge and practical skills to design, analyze, and deploy intelligent data-driven solutions by integrating principles of mathematics, statistics, and computing with modern techniques in artificial intelligence, machine learning, and data science.

Equivalence: The combined first and second semesters of the 2-year M.Sc. in Artificial Intelligence and Data Science (M.Sc. (AI & DS)) degree program are equivalent to a 1-year Postgraduate Diploma in Artificial Intelligence and Data Science (PG Diploma (AI & DS))

Exit option: At the end of the 1st year of M.Sc. in AI &DS (completion of 46 credits) students may opt for exit out with **B.Sc. in AI & DS degree at Level 6 of NHEQF**.

Course Credit Structure

Sem	Course Code	Course Title	Course Type	Credit Pattern			Credit Value	Marks Distribution		
				Lecture (L)	Tutorial (T)	Practice (P)		Summative assessment	Continuous assessment	Total Marks
S E M I	AIDS-MJR-T-401	Mathematical Foundation for AI and Data Science	Major (Th)	3	1	0	4	80	20	100
	AIDS-MJR-T-402	Statistics and Data Analytics	Major (Th)	3	1	0	4	80	20	100
	AIDS-MJR-T-403	Data Structure and Algorithms	Major (Th)	3	1	0	4	80	20	100
	AIDS-MJR-T-404	Database Management Systems	Major (Th)	3	1	0	4	80	20	100
	AIDS-MJR-P-405	Statistics and Data Analytics Laboratory	Major (Pr)	0	0	2	2	80	20	100
	AIDS-MJR-P-406	Data Structure and Algorithms Laboratory	Major (Pr)	0	0	2	2	80	20	100
	AIDS-MJR-P-407	Database Management Systems Laboratory	Major (Pr)	0	0	2	2	80	20	100
	AIDS-VAC-449	449 A: Communicative English and Business Presentation 449 B: Data Analytics using Spreadsheets	Value-added Course	–	–	–	–	Gradation based evaluation		100
	NHEQF Level 6.5 :: UGC Course Level 400-449				12	4	6	22		800
S E M II #	AIDS-IDS-451	Artificial Intelligence and Data Science in Practice*	Interdisciplinary	2	0	2	4	40 (Th) + 40 (Pr)	10 (Th) + 10 (Pr)	100
	AIDS-MNE-452	Scientific Computing	Minor (Th+Pr)	2	0	2	4	40 (Th) + 40 (Pr)	10 (Th) + 10 (Pr)	100
	AIDS-MJR-T-453	Data Warehousing and Data Mining	Major (Th)	3	1	0	4	80	20	100
	AIDS-MJR-T-454	Artificial Intelligence and Machine Learning	Major (Th)	3	1	0	4	80	20	100
	AIDS-MNE-T-455	Elective-I	Minor (Elec Th)	3	1	0	4	80	20	100
	AIDS-MJR-P-456	Data Mining and Visualization Laboratory	Major (Pr)	0	0	2	2	80	20	100
	AIDS-MJR-P-457	Artificial Intelligence and Machine Learning Laboratory	Major (Pr)	0	0	2	2	80	20	100
	AIDS-DISS-458	Dissertation-I	Dissertation	0	0	2	2	-	-	100
	AIDS-VAC-499	499A: Scientific Writing with LaTeX 499B: Data Analysis on Cloud	Value-added Course	-	-	-	-	Gradation based evaluation		100
	NHEQF Level 6.5 :: UGC Course Level 450-499				13	3	10	26		900

* Meant for an interdisciplinary course for students from different programmes of KU including M.Sc.(AI & DS). M.Sc.(AI & DS) students will opt for an interdisciplinary course from M.Sc.(AI & DS)/ other PG programmes of KU (mandatory).

After the 1st and 2nd semesters, students may opt for the exit option with a Postgraduate Diploma in AI & DS (as per UGC nomenclature – NHEQF Level 6).

SEM III	AIDS-IKS-T-501	Indian Knowledge Systems in AI and Computing*	IKS (Th)	3	1	0	4	80	20	100
	AIDS-MJR-T-502	Advanced Machine Learning	Major (Th)	3	1	0	4	80	20	100
	AIDS-MJR-T-503	Deep Learning and Generative AI	Major (Th)	3	1	0	4	80	20	100
	AIDS-MJR-504	Big Data Algorithms & Analytics	SEC (Th & Pr)	2	0	2	4	40 (Th) + 40 (Pr)	10 (Th) + 10 (Pr)	100
	AIDS-MNE-T-505	Elective-II	Minor (Elec Th)	3	1	0	4	80	20	100
	AIDS-MJR-P-506	Advanced Machine Learning Laboratory	Major (Pr)	0	0	2	2	80	20	100
	AIDS-MJR-P-507	Deep Learning and Generative AI Laboratory	Major (Pr)	0	0	2	2	80	20	100
	AIDS-DISS-508	Dissertation-II	Dissertation	0	0	4	4	-	-	200
	NHEQF Level 6.5 :: UGC Course Level 500-549				14	4	10	28		
* Course on IKS (Indian Knowledge System)										
SEM IV	AIDS-DISS-551	Dissertation-III	Dissertation	0	0	8	8	-	-	400
	AIDS-GV-552	Grand Viva	Grand Viva	-	-	-	4	-	-	100
	AIDS-VAC-599	Research Methodology	Value-added Course	-	-	-	-	-	-	100
	NHEQF Level 6.5 :: UGC Course Level 550-599				0	0	8	12		
Grand total							88			3200

Credit Distribution – 88 Credits

Major (MJR) courses – 50 credits	Minor [MNR] + Minor (Elec) [MNE] + SEC courses – 4 + 8 + 4 = 16 credits	
Theory + Practical Courses: 16 Theory Credits: 27 Tutorial Credits: 9 Practical Credits: 14	MNR (Mandatory)	MNE [Electives] – 8 Credits & SEC Courses – 4 credits
	Theory + Practical	
	Courses: 1 Theory Credits: 2 Practical Credits: 2	Courses: 3 Theory Credits: 8 Tutorial Credits: 2 Practical Credits: 2
Total: 16 courses and 50 credits	Total: 1 course and 4 credits	Total: 3 courses and 12 credits

Interdisciplinary (IDS) – 4 credits	Indian Knowledge System (IKS) – 4 credits	Dissertation + Grand Viva – 10+4 = 14 credits
Course: 1 Theory Credits: 2 Practical Credits: 2	Course: 1 Theory Credits: 3 Tutorial Credits: 1	Course: Dissertation (2) + Grand Viva (1) Dissertation Credits: 10 Grand Viva Credits: 4
Total : 1 course and 4 credits	Total : 1 course and 4 credits	Total : 3 courses and 14 credits

Learning Outcomes Mapping: Programme Learning Outcomes (PLOs) to Course Learning Outcomes (CLOs)

Legend:  3 = High  2 = Moderate  1 = Low  – = No mapping

Semester I

Course	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
AIDS-MJR-401	3	2	1	1	–	–	–	–	–	–	–	1
AIDS-MJR-402	3	3	1	3	2	1	–	–	1	1	–	1
AIDS-MJR-403	3	3	2	1	1	–	–	–	–	–	–	1
AIDS-MJR-404	2	2	2	2	1	2	–	–	1	1	–	1
AIDS-MJR-405	2	3	2	3	2	1	–	1	1	–	–	2
AIDS-MJR-406	2	3	3	2	1	–	–	1	–	–	–	2
AIDS-MJR-407	2	2	3	3	1	2	–	1	1	1	–	2

Semester II

Course	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
AIDS-MJR-451	2	3	3	3	3	1	1	2	3	2	1	2
AIDS-MNE-452	2	2	2	2	2	3	1	2	1	1	–	2
AIDS-MJR-453	3	3	2	3	3	2	2	1	2	1	–	2
AIDS-MJR-454	3	3	3	2	3	2	3	1	2	2	–	2
AIDS-MNE-455	2	2	2	2	2	2	2	2	3	2	–	3
AIDS-MJR-456	2	3	3	3	3	2	2	2	2	1	–	2
AIDS-MJR-457	2	3	3	3	3	2	3	2	2	2	–	2
AIDS-DISS-458	3	3	2	3	3	2	3	3	3	2	3	3

Semester III

Course	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
AIDS-MJR-501	 2	 1	 1	 1	 1	 —	 —	 2	 3	 3	 3	 2
AIDS-MJR-502	 3	 3	 3	 2	 3	 1	 3	 1	 1	 1	 —	 2
AIDS-MJR-503	 3	 3	 3	 2	 3	 2	 3	 1	 2	 1	 —	 2
AIDS-MJR-504	 3	 3	 3	 3	 2	 3	 2	 2	 2	 1	 —	 2
AIDS-MNE-505	 2	 2	 2	 2	 2	 2	 2	 2	 3	 2	 —	 3
AIDS-MJR-506	 2	 3	 3	 3	 3	 2	 3	 2	 2	 1	 —	 2
AIDS-MJR-507	 2	 3	 3	 3	 3	 2	 3	 2	 2	 1	 —	 2
AIDS-DISS-508	 2	 2	 3	 3	 3	 2	 3	 3	 3	 2	 1	 3

Semester IV

Course	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
AIDS-MJR-551	 2	 1	 2	 2	 2	 1	 1	 3	 2	 2	 1	 2
AIDS-DISS-552	 3	 3	 3	 3	 3	 2	 3	 3	 3	 2	 2	 3
AIDS-GV-552	 2	 2	 3	 2	 2	 1	 2	 3	 2	 2	 1	 3

FIRST SEMESTER

Course Code: AIDS-MJR-T-401

Course Category: Major

Course Title: Mathematical Foundation for AI and Data Science

Prerequisites: None

Course Type: Theory

Credit Structure					Marks Distribution			Objective	Course Learning Outcomes
Lecture	Tutorial	Practice	Total Credit	Hours	Summative Assessment	Continuous/ Internal Assessment	Total Marks	To develop a strong mathematical foundation in functions, algebra, calculus, and discrete structures for analyzing and solving computational problems.	- Analyze and classify functions and relations and solve recurrence relations using appropriate mathematical techniques. - Apply matrix and vector operations to solve linear systems and perform eigenvalue-based analysis. - Understand and utilize algebraic structures such as groups, rings, and fields in computational contexts. - Evaluate limits, derivatives, integrals, and differential equations for single and multivariable functions. - Apply concepts of discrete mathematics, including logic, combinatorics, and graph theory, to solve problems and construct proofs.
3	1	0	4	40	80	20	100		

Unit 1: Functions and Relations: Definition and type of functions, mappings, injection, bijection and surjection, equivalence relations and partitions, partial ordering relation, Lattices and their applications, generating functions, recurrence relations, solution of linear homogeneous and non- homogeneous recurrence relations by the method of generating functions and particular solution method. **[6H]**

Unit 2: Linear Algebra: Basic properties of matrices and vectors: scalar multiplication, linear transformation, transpose, conjugate, rank, determinant, Inner and outer products, matrix multiplication, matrix inverse, unit vectors, symmetric matrix, matrix factorization concept/LU decomposition, Gaussian/Gauss-Jordan elimination, solving $Ax=b$ linear system of equation, Vector space, basis, span, orthogonality, orthonormality, linear least square, eigenvalues, eigenvectors. **[8H]**

Unit 3: Algebraic Structures: Groups, Rings and Fields, Group Codes, Concepts of Vector Spaces. **[8H]**

Unit 4: Calculus: Functions of a single variable, limit, continuity, differentiability, Mean value theorems, indeterminate forms, L'Hopital's rule, Maxima and minima, Product and chain rule, Taylor's series, infinite series summation/integration concepts, Fundamental and mean value-theorems of integral calculus, evaluation of definite and improper integrals, Beta and gamma functions, Functions of multiple variables, limit, continuity, partial derivatives, Basics of ordinary and partial differential equations. **[9H]**

Unit 5: Discrete Mathematics: Sets, subsets, power sets, set operations, Counting functions, combinatorics, countability, basic proof techniques: induction, proof by contradiction, Basics of inductive, deductive, and propositional logic, Graphs theory. **[9H]**

Suggested Reading List

- Narsingh Deo, Graph Theory With Applications To Engineering And Computer Science, PHI Learning
- C. L. Liu, Elements of Discrete Mathematics, TMH, 2000.
- Kenneth H. Rosen; Discrete Mathematics and its applications; TMH.
- K. H. Rosen, Discrete Mathematics and applications, fifth edition 2003, TMH.
- Ross, S., A First Course in Probability, Collier Macmillan, New York, 1976
- Liu, C.L., Introduction to Combinatorial Mathematics, McGraw Hill. 1996
- R.P. Grimaldi, B. V. Ramana, Discrete and Combinatorial mathematics: An applied introduction, Pearson Education, 2007
- Murray, R., J. Spiegel, and R. Schiller. Schaum's outline of probability and statistics. 2013.
- Lipschutz, Seymour, and Marc Lars Lipson. Discrete mathematics. McGraw-Hill, 2007.

FIRST SEMESTER

Course Code: AIDS-MJR-T-402

Course Category: Major

Course Title: Statistics and Data Analytics

Prerequisites: None

Course Type: Theory

Credit Structure					Marks Distribution			Objective	Course Learning Outcomes
Lecture	Tutorial	Practice	Total Credit	Hours	Summative Assessment	Continuous/ Internal Assessment	Total Marks		
3	1	0	4	40	80	20	100	To equip students with fundamental concepts and analytical techniques in data analytics, probability, and statistical modeling for data-driven decision making.	- Understand data analytics processes, including data collection, preprocessing, and ETL techniques. - Apply descriptive statistics and probability concepts to summarize and analyze data. - Analyze probability distributions and sampling methods for real-world data modeling. - Perform statistical inference using hypothesis testing, confidence intervals, and ANOVA techniques. - Develop and evaluate predictive models using regression, classification, and dimensionality reduction methods.

Unit 1: Introduction to Data Analytics & Data Preparation: Introduction to data analytics and data science, types of data (structured, unstructured, categorical, numerical), data collection methods and sources, data blending and preparation, data preprocessing techniques, ETL (Extract, Transform, Load) processes, data mining concepts, data science project life cycle. **[8H]**

Unit 2: Descriptive Statistics & Probability Fundamentals: Data summaries and descriptive statistics, measures of central tendency and dispersion, variance, covariance and correlation, basic probability concepts, probability calculus, conditional probability, Bayes' theorem, mathematical expectation. **[8H]**

Unit 3: Probability Distributions & Sampling: Uniform distribution, normal distribution, exponential distribution, binomial distribution, chi-square distribution, Student's t-distribution, F-distribution, central limit theorem, sampling techniques, random sample generation, measurement, errors in data. **[8H]**

Unit 4: Statistical Inference & Hypothesis Testing: Hypothesis testing, A/B testing, confidence intervals, p-values, t-test, Z-test, F-test, ANOVA, post hoc analysis, sign test, Wilcoxon signed-rank test, Spearman's rank-order correlation. **[8H]**

Unit 5: Advanced Analytics & Modeling Techniques: Regression, bias-variance tradeoff, linear regression, multivariate regression, subset selection, shrinkage methods, principal component regression, partial least squares, logistic regression, linear discriminant analysis, principal component analysis, multifactor dimensionality reduction, Gaussian mixture models, expectation maximization, time series analysis, ARMA models. **[8H]**

Suggested Reading List

- Walpole, Ronald E., Raymond H. Myers, Sharon L. Myers, and Keying Ye. *Probability and Statistics for Engineers and Scientists*. Pearson, 2012.
- Cady, Field. *The data science handbook*. John Wiley & Sons, 2017.
- Peter Bruce and Andrew Bruce, *Practical Statistics for Data Science*, O'Reilly, 2017.
- Moreira, João, Andre Carvalho, and Tomás Horvath. *A general introduction to data analytics*. John Wiley & Sons, 2018.
- J. Han and M. Kamber, *Data Mining: Concepts and Techniques*, Morgan Kaufmann/Elsevier India, 2001.
- Friedman, Jerome, Trevor Hastie, and Robert Tibshirani. *The elements of statistical learning*. Vol. 1. No. 10. New York: Springer series in statistics, 2001.
- Alpaydin, Ethem. *Introduction to machine learning*. MIT press, 2009.
- D. Hand, H. Mannila, and P. Smyth. *Principles of Data Mining*, MIT Press, 2001.
- Pujari, Arun K. *Data mining techniques*. Universities press, 2001.

FIRST SEMESTER**Course Code: AIDS-MJR-T-403****Course Category: Major****Course Title: Data Structure and Algorithms****Prerequisites: None****Course Type: Theory**

Credit Structure					Marks Distribution			Objective	Course Learning Outcomes
Lecture	Tutorial	Practice	Total Credit	Hours	Summative Assessment	Continuous / Internal Assessment	Total Marks	To provide students with a strong foundation in data structures and algorithmic techniques for efficient storage, organization, retrieval, and processing of data. The course develops analytical and problem-solving skills through the study of algorithm complexity and the design and application of linear and non-linear data structures relevant to computing.	- Analyze the time and space complexity of algorithms using asymptotic notations and evaluate their computational efficiency. - Design and implement solutions using linear data structures such as arrays, strings, stacks, queues, and linked lists. - Apply recursion and tree-based data structures to solve computational problems and perform efficient data organization. - Utilize advanced tree structures, graph representations, and associated operations for modeling and solving real-world problems. - Compare and implement searching, sorting, and hashing techniques, selecting appropriate methods based on problem requirements and performance considerations.
3	1	0	4	40	80	20	100		

Unit 1: Algorithm Analysis and Linear Sequential Data Structures : Introduction to Algorithms, Time and Space Analysis of Algorithms, Asymptotic Notations. Linear Data Structures: Sequential Storage Representation- Array and Strings operations and their Applications **[8H]**

Unit 2: Stacks, Queues and Linked Data Structures : Stacks, Queues, Deques, Linked Lists, Singly Linked Lists, Circularly Linked List, Doubly Linked Lists and their applications **[10H]**

Unit 3: Recursion Design: Recursion design of algorithms, Tail Recursion, When not to use Recursion, Removal of Recursion **[4H]**

Unit Non-linear Data Structures: Trees, Binary Trees, Binary Search Tree, Traversals and Threads, Insertion and Deletion Algorithms. **[6H]**

Unit 5: Advanced Tree Structures: Height Balanced Trees, Weight Balanced Trees, B- Trees, B+ Trees. **[4H]**

Unit 6: Applications of Trees: Graphs-Representation, Sorting and Searching-Review of Various Algorithms, Hashing. **[8H]**

Suggested Reading List

1. S. Lipschutz, Data Structures, McGraw-Hill, 1986.
2. Ellis Horowitz, S. Sahni, D. Mehta Fundamentals of Data Structures in C++, Galgotia Book Source, New Delhi.
3. T.H. Cormen, C.E. Leiserson, R.L. Rivest and C. Stein, Introduction to Algorithms (2nd ed.), Prentice-Hall of India, 2006
4. Y. Langsam, M. Augenstein and A. Tannenbaum, Data Structures using C and C++, Pearson Education Asia, 2nd Edition, 2002.
5. Aho Alfred V., Hopcroft John E., Ullman Jeffrey D., "Data Structures and Algorithms", Addison Wesley

FIRST SEMESTER**Course Code: AIDS-MJR-T-404****Course Category: Major****Course Title: Database Management Systems****Prerequisites: None****Course Type: Theory**

Credit Structure					Marks Distribution			Objective	Course Learning Outcomes
Lecture	Tutorial	Practice	Total Credit	Hours	Summative Assessment	Continuous / Internal Assessment	Total Marks	To introduce students to fundamental concepts of database management systems, including data modeling, relational algebra, SQL, normalization, and transaction management for designing efficient data storage solutions.	- Understand the architecture of DBMS, data models, and the role of database users and administrators. - Design entity-relationship models and translate them into relational schemas. - Formulate queries using relational algebra, relational calculus, and SQL including advanced features. - Apply normalization techniques to design anomaly-free relational database schemas. - Analyze RDBMS internals including query optimization, transaction management, concurrency control, and recovery..
3	1	0	4	40	80	20	100		

Unit 1: Introduction to DBMS :Concept and overview of DBMS, Data Models (hierarchical, network, relational, object-oriented), Database Languages, Database Administrator, Database Users, Three Schema Architecture of DBMS. **[8H]**

Unit 2: Entity-Relationship Model :Basic concepts, Design Issues, Mapping Constraints, Keys, Entity-Relationship Diagram, Weak Entity Sets, Extended E-R features (specialization, generalization, aggregation). **[6H]**

Unit 3: Relational Model & SQL: Structure of relational databases, Relational Algebra, Relational Calculus, Extended Relational Algebra Operations, Views, Modifications of the Database. SQL: Concept of DDL, DML, DCL, basic structure, set operations, aggregate functions, null values, domain constraints, referential integrity constraints, assertions, views, nested subqueries, Database security application development using SQL, stored procedures and triggers. **[12H]**

Unit 4: Relational Database Design : Functional Dependency, Different anomalies in designing a database, Normalization using functional dependencies, Decomposition, Boyce-Codd Normal Form (BCNF), 3NF, normalization using multi-valued dependencies, 4NF, 5NF. **[6H]**

Unit 5: RDBMS Internals & File Organization : Physical data structures, Query optimization: join algorithms, statistics and cost-based optimization. Transaction processing, Concurrency control and Recovery Management: transaction model properties, serializability, lock-based protocols, two-phase locking. File Organization and Index Structures: file and record concept, placing file records on disk, fixed and variable sized records, single-level and multi-level indexes, B-trees and B+ trees. **[8H]**

Suggested Reading List:

1. Henry F. Korth and Silberschatz Abraham, Database System Concepts, McGraw-Hill.
2. Elmasri, R. and Navathe, S.B., Fundamentals of Database Systems, Pearson/Addison-Wesley.
3. Ramakrishnan, R. and Gehrke, J., Database Management Systems, McGraw-Hill.
4. Date, C. J., Introduction to Database Management, Addison-Wesley.
5. Ullman, J.D., Principles of Database Systems, Galgotia Publications.
6. Gray, J. and Reuter, A., Transaction Processing: Concepts and Techniques, Morgan Kaufmann.
7. Jain: Advanced Database Management System CyberTech

FIRST SEMESTER

Course Code: AIDS-MJR-P-405

Course Category: Major

Course Title: Statistics and Data Analytics Laboratory

Prerequisites: Basic Statistics, Probability, and Python Programming

Course Type: Practical

Credit Structure					Marks Distribution			Objective	Course Learning Outcomes
Lecture	Tutorial	Practice	Total Credit	Hours	Summative Assessment	Continuous/Internal Assessment	Total Marks	To provide hands-on experience in statistical analysis and data analytics using Python/R and standard statistical libraries.	- Implement data preprocessing, cleaning, and transformation tasks using Python/R. - Compute descriptive statistics and visualize data distributions using appropriate libraries. - Apply statistical tests, hypothesis testing, and regression analysis on real-world datasets. - Build and evaluate classification and dimensionality reduction models using scikit-learn or R. - Produce analytical reports and visualizations from data using Python/R.
0	0	2	2	30	80	20	100		

Laboratory Syllabus

1. **Image Preprocessing and Enhancement:** Perform image resizing, normalization, filtering, noise removal, contrast enhancement, and augmentation using Python and OpenCV.
2. **Image Feature Extraction:** Extract color, texture, shape, and deep features from multimedia images.
3. **Image Classification:** Implement CNN-based image classification using TensorFlow/Keras or PyTorch.
4. **Object Detection:** Implement object detection using YOLO or other pretrained deep learning models.
5. **Image Segmentation:** Perform semantic or instance segmentation using pretrained AI models.
6. **Image Generation:** Generate and transform images using autoencoders, GANs, or pretrained generative models.
7. **Audio Processing:** Perform audio loading, preprocessing, waveform visualization, noise reduction, and spectrogram generation using Librosa.
8. **Audio Feature Extraction:** Extract MFCC, spectral, and temporal features from audio signals.
9. **Audio Classification:** Develop an AI model for speech, music, or environmental sound classification.
10. **Speech Recognition:** Implement speech-to-text using pretrained speech recognition models.
11. **Video Processing:** Perform video loading, frame extraction, resizing, motion detection, and basic video analysis using OpenCV.
12. **Video Classification:** Implement AI-based video or human-action classification using suitable deep learning models.
13. **Multimedia Captioning:** Generate textual descriptions for images or videos using pretrained vision-language models.
14. **Multimodal AI:** Combine image, audio, or text features for multimedia classification or retrieval.
15. **Mini Project:** Develop and evaluate an AI-based multimedia application integrating image, audio, video, or multimodal data.

Suggested Software/Tools: Python, Jupyter Notebook, Google Colab, NumPy, Pandas, OpenCV, Matplotlib, Scikit-learn, TensorFlow/Keras or PyTorch, Librosa, Hugging Face Transformers, and Kaggle/UCI multimedia datasets.

FIRST SEMESTER

Course Code: AIDS-MJR-P-406

Course Category: Major

Course Title: Data Structure and Algorithms Laboratory

Prerequisites: Basic Programming in C/C++ or Python

Course Type: Practical

Credit Structure					Marks Distribution			Objective	Course Learning Outcomes
Lecture	Tutorial	Practice	Total Credit	Hours	Summative Assessment	Continuous/ Internal Assessment	Total Marks	To reinforce theoretical concepts of data structures and algorithms through hands-on implementation and problem-solving in C/C++ or Python.	• Implement and test fundamental data structures: arrays, linked lists, stacks, queues, and trees. • Design and code recursive algorithms and analyze their performance empirically. • Implement and compare sorting and searching algorithms on different data sets. • Build graph representations and implement BFS, DFS, and shortest path algorithms. • Analyze time and space complexity of implemented algorithms through benchmarking.
0	0	2	2	30	80	20	100		

Laboratory Syllabus

1. **Array and String Operations:** Implement insertion, deletion, searching, sorting, traversal, and common string manipulation operations.
2. **Linked Lists:** Implement singly, doubly, and circular linked lists with insertion, deletion, searching, and traversal operations.
3. **Stacks and Queues:** Implement stacks and queues using arrays and linked lists, including circular queue operations.
4. **Recursion:** Implement recursive solutions for factorial, Fibonacci series, Tower of Hanoi, and related problems.
5. **Binary Search Tree:** Implement insertion, deletion, searching, and tree traversal operations in a binary search tree.
6. **AVL Tree:** Implement AVL tree insertion and deletion with LL, RR, LR, and RL rotations.
7. **Sorting Algorithms:** Implement and compare bubble, insertion, selection, merge, quick, and heap sort algorithms.
8. **Graph Representation and Traversal:** Implement adjacency matrix/list representations and perform BFS and DFS traversal.
9. **Shortest Path Algorithm:** Implement Dijkstra's algorithm and analyze shortest paths in weighted graphs.
10. **Hashing:** Implement hash tables with collision-resolution techniques such as linear probing, quadratic probing, and chaining.
11. **Priority Queue and Heap:** Implement min-heaps/max-heaps and priority queue operations.
12. **Divide-and-Conquer:** Implement binary search, merge sort, and quick sort and analyze their performance.
13. **Greedy Algorithms:** Implement problems such as fractional knapsack, activity selection, and Huffman coding.
14. **Dynamic Programming:** Implement problems such as 0/1 knapsack, matrix-chain multiplication, and longest common subsequence.
15. **Mini Project:** Develop a data-structure-based application integrating appropriate searching, sorting, graph, tree, or hashing techniques.

Suggested Programming Languages/Tools: C, C++, or Python; GCC/G++, Visual Studio Code, Jupyter Notebook, or Google Colab.

FIRST SEMESTER

Course Code: AIDS-MJR-P-407
Major

Course Category:

Course Title: Database Management Systems Laboratory

Prerequisites: Basic Programming Skill

Course Type: Practical

Credit Structure					Marks Distribution			Objective	Course Learning Outcomes
Lecture	Tutorial	Practice	Total Credit	Hours	Summative Assessment	Continuous/Internal Assessment	Total Marks	To provide hands-on experience in designing, implementing, and querying relational databases using SQL and DBMS tools such as MySQL or PostgreSQL.	• Design ER diagrams and translate them into normalized relational schemas. • Write and execute DDL and DML statements to create and manipulate databases. • Formulate complex SQL queries using joins, subqueries, aggregations, and views. • Implement stored procedures, triggers, and transactions in a relational DBMS. • Use database tools (MySQL/PostgreSQL) for creating and administering databases.
0	0	2	2	30	80	20	100		

Laboratory Syllabus

1. **ER Diagram and Schema Design:** Design ER diagrams for real-world applications and map entities, relationships, and attributes into relational schemas.
2. **Database Creation and Management:** Create, modify, and manage databases and tables using MySQL/PostgreSQL.
3. **DDL Operations:** Implement CREATE, ALTER, DROP, and related database definition commands.
4. **DML Operations:** Perform INSERT, UPDATE, DELETE, and SELECT operations on relational tables.
5. **Complex SQL Queries:** Implement inner, outer, and cross joins, subqueries, nested queries, and set operations.
6. **Aggregate Functions and Grouping:** Apply aggregate functions such as COUNT, SUM, AVG, MIN, and MAX with GROUP BY and HAVING.
7. **Views and Indexes:** Create, modify, and query views and implement indexes to improve query performance.
8. **Stored Procedures and Functions:** Develop and execute stored procedures and user-defined functions for database applications.
9. **Triggers and Cursors:** Implement triggers for automated database actions and cursors for row-by-row processing.
10. **Transaction Management:** Implement transactions using COMMIT, ROLLBACK, and SAVEPOINT and demonstrate transaction consistency.
11. **Database Normalization:** Normalize relational schemas from 1NF through 2NF, 3NF, and BCNF and identify functional dependencies.
12. **Query Optimization:** Analyze query execution plans and apply appropriate indexing and query optimization techniques.
13. **Database Security:** Implement users, roles, privileges, and access-control mechanisms in a relational database.
14. **Application–Database Connectivity:** Connect a database with a Python/C++ application and perform CRUD operations.
15. **Mini Project:** Design and implement a complete database system for a real-world application, including ER modelling, normalization, SQL queries, transactions, and application connectivity.

Suggested Software/Tools: MySQL, PostgreSQL, MySQL Workbench/pgAdmin, Python, SQLAlchemy or suitable database connectivity libraries.

FIRST SEMESTER

Course Code: AIDS-VAC-449A

Course Category: VAC

Course Title: Communicative English and Business Presentation **Prerequisites:** None.

Course Type: Theory+Practice

Credit Structure					Marks Distribution			Objective	Course Learning Outcomes
Lecture	Tutorial	Practice	Total Credit	Hours	Summative Assessment	Continuous/ Internal Assessment	Total Marks	To develop effective English communication, vocabulary, writing, comprehension, and professional presentation skills for academic, workplace, and business communication.	● Apply vocabulary-building techniques using roots, prefixes, suffixes, synonyms, antonyms, and abbreviations. ● Construct clear, coherent, grammatically correct, and well-organized written communication. ● Identify and correct common grammatical and stylistic errors in writing. ● Develop concise, logical, and effective descriptive and professional writing. ● Deliver effective business presentations using appropriate verbal, visual, and non-verbal communication techniques.
0	0	0	0	20			100		

Unit 1: Vocabulary Building: Concept of word formation, root words and their origins from foreign languages and their use in English, prefixes and suffixes from foreign languages and their use in forming derivatives, synonyms, antonyms, standard abbreviations, contextual vocabulary, and strategies for vocabulary enrichment. **[4H]**

Unit 2: Basic Writing Skills: Sentence structures, simple, compound, and complex sentences, use of phrases and clauses in sentences, importance and application of proper punctuation, creating coherence and cohesion, principles of paragraph organization, logical sequencing of ideas, techniques for precise and concise writing. **[4H]**

Unit 3: Identifying and Correcting Common Errors in Writing: Subject–verb agreement, noun–pronoun agreement, misplaced and dangling modifiers, appropriate use of articles, prepositions, redundant expressions, clichés, common grammatical errors, sentence correction, and editing practices. **[4H]**

Unit 4: Nature and Style of Sensible Writing: Principles of effective writing, describing, defining, classifying, providing examples and evidence, developing logical arguments, writing effective introductions and conclusions, organizing ideas, maintaining clarity and coherence, and techniques for professional and formal writing. **[4H]**

Unit 5: Writing Practices and Business Presentation: Reading comprehension, précis writing, essay writing, principles of effective oral communication, structure and organization of business presentations, preparation of presentation content, use of visual aids and presentation slides, verbal and non-verbal communication, delivery techniques, audience engagement, handling questions and feedback, and professional presentation etiquette. **[4H]**

Suggested Reading List

1. Wren, P. C. and H. Martin. *High School English Grammar and Composition*. S. Chand Publishing.
2. Michael Swan. *Practical English Usage*. Oxford University Press.
3. Norman Lewis. *Word Power Made Easy*. Penguin Books.
4. John Seely. *The Oxford Guide to Effective Writing and Speaking*. Oxford University Press.
5. Raymond Murphy. *English Grammar in Use*. Cambridge University Press.
6. David Gruber. *Business English: A Complete Guide to Professional Communication*. Pearson.
7. John Hughes and Jon Naunton. *Business Result: Intermediate*. Oxford University Press.

FIRST SEMESTER

Course Code:AIDS-VAC-449B

Course Category: VAC

Course Title: Data Analytics using Spreadsheets

Prerequisites:None.

Course Type: Theory+Practice

Credit Structure					Marks Distribution			Objective	Course Learning Outcomes
Lecture	Tutorial	Practice	Total Credit	Hours	Summative Assessment	Continuous/ Internal Assessment	Total Marks		
0	0	0	0	20			100		• Apply spreadsheet techniques for data organization, cleaning, and preprocessing. • Use formulas, functions, and conditional operations for data analysis. • Analyze datasets using sorting, filtering, pivot tables, and statistical functions. • Create effective charts, dashboards, and visual reports from data. • Apply spreadsheet-based analytical techniques to solve practical data-driven problems.

Unit 1: Spreadsheet Fundamentals and Data Preparation: Spreadsheet interface and workbook management, data types, cell references, formatting, data entry and validation, importing datasets, sorting and filtering, handling missing and duplicate data, text and date functions, data cleaning, and basic spreadsheet automation. **[4H]**

Unit 2: Spreadsheet Formulas and Statistical Analysis: Mathematical and logical functions, conditional functions, lookup and reference functions, text functions, statistical functions, descriptive statistics, measures of central tendency and dispersion, conditional calculations, and basic probability analysis. **[4H]**

Unit 3: Data Analysis and What-If Techniques: Pivot tables and pivot charts, grouping and summarization, multi-dimensional analysis, conditional formatting, what-if analysis, goal seek, data tables, scenario manager, correlation, regression analysis, trend analysis, and forecasting techniques. **[4H]**

Unit 4: Data Visualization and Dashboard Development: Principles of effective data visualization, chart selection, column, bar, line, pie, scatter, and combination charts, dynamic charts, slicers, interactive dashboards, KPI cards, conditional formatting, and presentation of analytical results. **[4H]**

Unit 5: Advanced Spreadsheet Analytics: Power Query/data transformation concepts, data modelling, relationships between tables, Power Pivot concepts, calculated columns and measures, advanced filtering, automated reporting, dashboard design, and development of spreadsheet-based decision-support solutions. **[4H]**

Suggested Practical Emphasis

1. **Data Import and Cleaning:** Import CSV/Excel datasets and handle missing values, duplicates, inconsistent formats, and outliers.
2. **Formula-Based Analysis:** Use IF, SUMIFS, COUNTIFS, XLOOKUP/VLOOKUP, text functions, date functions, and statistical functions for data analysis.
3. **Descriptive Analytics:** Calculate mean, median, mode, standard deviation, variance, quartiles, and other summary statistics.
4. **Pivot Table Analysis:** Create pivot tables and pivot charts to analyze sales, student, financial, healthcare, or other datasets.
5. **Data Visualization:** Select appropriate charts and create informative visualizations for different analytical questions.
6. **Correlation and Regression:** Analyze relationships between variables and perform basic regression using spreadsheet tools.
7. **What-If Analysis:** Apply Goal Seek, Scenario Manager, and Data Tables to solve decision-making problems.
8. **Forecasting:** Perform trend analysis and generate basic forecasts from historical datasets.
9. **Interactive Dashboard:** Develop an interactive dashboard using charts, slicers, filters, KPIs, and conditional formatting.
10. **Power Query/Data Transformation:** Import, combine, clean, and transform data from multiple sources.
11. **Business Decision Analysis:** Develop spreadsheet models for budgeting, sales forecasting, inventory management, or resource planning.
12. **Mini Project:** Complete an end-to-end analytics project involving **data collection/import → cleaning → analysis → visualization → dashboard → interpretation and recommendations**.

Suggested Datasets: Sales, retail, finance, education, healthcare, agriculture, transportation, and public datasets from **Kaggle, UCI, government open-data portals, or institutional datasets**.

SECOND SEMESTER

Course Code: AIDS-IDS-451

Course Category: Interdisciplinary

Course Title: Artificial Intelligence and Data Science in Practice

Prerequisites: None

Course Type: Theory+Practical

Credit Structure					Marks Distribution			Objective	Course Learning Outcomes
Lecture	Tutorial	Practice	Total Credit	Hours	Summative Assessment	Continuous/ Internal Assessment	Total Marks		
2	0	2	4	40	80	20	100	To provide an interdisciplinary introduction to AI and data science concepts, tools, and applications, enabling students from diverse academic backgrounds to apply data-driven and AI techniques to problems in their own fields.	- Understand the fundamental concepts of data science and artificial intelligence and their interdisciplinary relevance. - Apply data preprocessing, visualization, and exploratory data analysis techniques using standard tools. - Implement basic machine learning algorithms for classification, regression, and clustering on real-world datasets. - Critically analyze the societal, ethical, and domain-specific implications of AI and data science applications. - Develop a small interdisciplinary project applying AI/data science methods to a domain of interest.

Unit 1: Introduction to Data Science and AI What is Data Science? — core problems and solutions, extracting intelligence from data; the data pipeline explained conceptually (collection → cleaning → analysis → insight → decision) using cross-disciplinary examples (e.g., chemical assay data, census/geographic data, survey data); types of data — structured, unstructured, categorical, numerical — and why data type determines valid analysis; introduction to Artificial Intelligence — definitions, brief history, narrow vs. general AI, rule-based vs. learning-based systems; applications of AI and data science across disciplines. This unit is purely conceptual — discussion and case-study based, with no coding component. **[6H]**

Unit 2: Exploratory Data Analysis and Visualization Basic statistics for EDA — mean, median, spread, correlation vs. causation; data visualization principles and techniques; using Pandas, Matplotlib and Seaborn (Python) or equivalent R tools; identifying patterns, outliers, and trends in data. Students may work with data in their respective fields in this regard. **[12H]**

Unit 3: Machine Learning Concepts — Concept First Supervised vs. unsupervised vs. semi-supervised learning explained through everyday analogies; regression (linear, logistic), classification (k-nearest neighbor, decision tree, random forest; clustering (K-means, hierarchical; dimensionality reduction (PCA). Algorithms are to be implemented using visual tools (Orange). **[12H]**

Unit 4: AI Applications Across Disciplines, Ethics, and Responsible AI Applications of data science and AI in banking and finance, biology and healthcare, education, agriculture, environmental science, computer vision, and natural language processing; ethical considerations in AI — bias, fairness, privacy, and accountability; introduction to responsible AI, illustrated through case studies relevant to various disciplines (e.g., bias in healthcare algorithms, misuse of environmental data, AI and research integrity). **[10H]**

Suggested Reading List

1. Cady, Field, The Data Science Handbook, John Wiley & Sons, 2017.
2. J. Han and M. Kamber, Data Mining: Concepts and Techniques, Morgan Kaufmann, 2001.
3. Pierson, Lillian, Data Science for Dummies, John Wiley & Sons, 2015.
4. Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, O'Reilly, 2nd ed., 2019 (reference only — for optional coding track).
5. VanderPlas, J., Python Data Science Handbook, O'Reilly, 2016 (reference only — for optional coding track).
6. Russell, S. and Norvig, P., Artificial Intelligence: A Modern Approach, 4th ed., Pearson.

SECOND SEMESTER

Course Code: AIDS-MNE-452

Course Category: Minor

Course Title: Scientific Computing

Prerequisites: None

Course Type: Theory+Practice

Credit Structure					Marks Distribution			Objective	Course Learning Outcomes
Lecture	Tutorial	Practice	Total Credit	Hours	Summative Assessment	Continuous/ Internal Assessment	Total Marks	To develop a strong mathematical foundation in functions, algebra, calculus, and discrete structures for analyzing and solving computational problems.	- Understand sources of numerical errors and apply iterative methods for solving nonlinear equations. - Apply polynomial interpolation and numerical differentiation/integration methods. - Solve initial value problems using numerical ODE methods (Euler, Runge-Kutta). - Formulate and solve linear programming problems using the simplex algorithm. - Implement scientific computing methods using Python (NumPy/SciPy) or MATLAB/Octave.
2	0	2	4	20L+30P	40(Th) + 40(Pr)	10(Th)+10(Pr)	100		

Unit 1: Errors and Nonlinear Equations: Definition and sources of errors (truncation, round-off); solutions of nonlinear equations — Bisection method, Newton-Raphson method and its variants, fixed point iterations, convergence analysis; Newton's method for non-linear systems. **[4H]**

Unit 2: Interpolation and Numerical Integration: Finite differences, polynomial interpolation (Lagrange, Newton's forward/backward); Numerical integration — Trapezoidal rule, Simpson's rules, Gaussian quadrature; error analysis. **[5H]**

Unit 3: Numerical Solution of ODEs: Initial value problems — Taylor series method, Euler and modified Euler methods, Runge-Kutta methods (RK2, RK4). **[5H]**

Unit 4: Optimization: Linear programming, simplex algorithm, duality; integer programming; constraint programming; knapsack problem; introduction to gradient-based optimization methods for ML (gradient descent, Newton's method for optimization). **[6H]**

Practical Component [30P] Implementation in Python/NumPy/SciPy or MATLAB/Octave; root finding algorithms; interpolation and curve fitting; numerical integration; ODE solving; linear programming using scipy.optimize; solving real-world numerical problems arising in data science and AI.

Suggested Reading List

1. D. Kincaid and W. Cheney, Numerical Mathematics and Computing, 7th ed., Cengage, 2013.
2. K.E. Atkinson, Introduction to Numerical Analysis, 2nd ed., John Wiley, 1989.
3. Rajaraman, V., Computer Oriented Numerical Methods, PHI Learning, 2018.
4. F.S. Hillier and G.J. Lieberman, Introduction to Operations Research, 9th ed., Tata McGraw-Hill, 2010.
5. Chong, E.K.P. and Zak, S.H., An Introduction to Optimization, John Wiley.
6. Trefethen, L.N. and Bau, D., Numerical Linear Algebra, SIAM.

SECOND SEMESTER

Course Code: AIDS-MJR-T-453

Course Category: Major

Course Title: Data Warehousing and Data Mining

Prerequisites: DBMS

Course Type: Theory

Credit Structure					Marks Distribution			Objective	Course Learning Outcomes
Lecture	Tutorial	Practice	Total Credit	Hours	Summative Assessment	Continuous/ Internal Assessment	Total Marks		
3	1	0	4	40	80	20	100	To introduce students to the concepts, techniques, and tools of data warehousing and data mining, enabling them to design data warehouses and apply mining algorithms for knowledge discovery from large datasets.	- Understand data warehousing concepts including architecture, OLAP, and multidimensional data analysis. - Apply data preprocessing techniques including cleaning, integration, transformation, and reduction. - Implement association rule mining algorithms for discovering frequent patterns and correlations. - Apply clustering and classification algorithms to analyze and categorize large datasets. - Explore specialized mining techniques for spatial, text, and web data

Unit 1: Data Warehousing and OLAP Data warehousing components, building a data warehouse, Data Warehouse Architecture, DBMS schemas for decision support (star, snowflake, fact constellation), Data Extraction, Cleanup, and Transformation Tools, Metadata, reporting, query tools and applications, Online Analytical Processing (OLAP), OLAP operations (roll-up, drill-down, slice, dice, pivot), multidimensional data analysis. **[8H]**

Unit 2: Data Preprocessing and Mining Overview Data mining functionalities, Data preprocessing — data cleaning, data integration and transformation, data reduction, data discretization and concept hierarchy generation; Architecture of a typical data mining system; Classification of data mining systems; KDD process. **[7H]**

Unit 3: Association Rule Mining Efficient and scalable frequent itemset mining methods (Apriori, FP-Growth); Mining various kinds of association rules; Association mining to correlation analysis; Constraint-based association mining; Applications of association mining. **[7H]**

Unit 4: Cluster Analysis Types of data in cluster analysis; Categorization of major clustering methods; Partitioning methods (K-means, K-medoids); Hierarchical methods ; Density-based methods; Grid-based methods; Model-based clustering; Clustering high-dimensional data; Outlier analysis. **[9H]**

Unit 5: Classification, Prediction and Advanced Mining Issues regarding classification and prediction; Nearest Neighbor classification; Decision Tree induction (ID3, C4.5); Bayesian classification; Rule-based classification; Support Vector Machines; Associative classification; Accuracy and error measures. **[9H]**

Suggested Reading List

1. Jiawei Han and Micheline Kamber, Data Mining: Concepts and Techniques, 3rd ed., Elsevier/Morgan Kaufmann.
2. Reema Thareja, Data Warehousing, Oxford University Press.
3. Paulraj Ponniah, Data Warehousing Fundamentals, John Wiley & Sons.
4. Margret H. Dunham, Data Mining: Introductory and Advanced Topics, Pearson Education.
5. Vikram Pudi and P. Radha Krishna, Data Mining, Oxford University Press.
6. D. Hand, H. Mannila, and P. Smyth, Principles of Data Mining, MIT Press.

SECOND SEMESTER

Course Code: AIDS-MJR-T-454

Course Category: Major

Course Title: Artificial Intelligence and Machine Learning

Prerequisites: Statistics & Data Analytics

Course Type: Theory

Credit Structure					Marks Distribution			Objective	Course Learning Outcomes
Lecture	Tutorial	Practice	Total Credit	Hours	Summative Assessment	Continuous/ Internal Assessment	Total Marks	To provide a comprehensive understanding of AI principles and foundational machine learning techniques, enabling students to design intelligent agents and apply learning algorithms to solve real-world problems.	- Understand the goals, history, and key paradigms of artificial intelligence and intelligent agent design. - Apply search strategies including uninformed, informed, and adversarial search algorithms. - Represent knowledge using logic and probabilistic frameworks, and perform reasoning under uncertainty. - Implement and evaluate supervised and unsupervised machine learning algorithms. - Recognize and discuss the applications and limitations of AI and ML techniques across domains.
3	1	0	4	40	80	20	100		

Unit 1: Introduction to Artificial Intelligence What is AI — importance, objectives; intelligent agents; state space representation; uninformed searches — BFS, DFS, IDFS; informed and heuristic searches — Branch & Bound, Best First Search, A* search; local searches and optimization — hill climbing, gradient descent, simulated annealing, genetic algorithms; Adversarial Search — Min-Max game tree. **[10H]**

Unit 2: Knowledge Representation and Reasoning Knowledge representation, organization, manipulation and acquisition; propositional logic and first-order predicate logic; resolution principle, Use of resolution in reasoning and question answering; Bayesian inferencing; Dempster-Shafer theory of beliefs; Fuzzy logic; structured representation of knowledge — semantic networks, frames, conceptual dependency; expert systems — rule-based system architecture, knowledge acquisition methods, explanation methods. **[10H]**

Unit 3: Introduction to Machine Learning Types of machine learning — supervised, unsupervised, and reinforcement learning; the ML pipeline: data collection, preprocessing, model selection, evaluation and tuning; bias-variance tradeoff; overfitting and underfitting; cross-validation; evaluation metrics (accuracy, precision, recall, F1-score, ROC-AUC), Regularization (Lasso, Ridge, Elastic Net); Ensemble methods — Random Forests, Bagging, Boosting (AdaBoost, Gradient Boosting, XGBoost). **[10H]**

Unit 4: Unsupervised & Reinforcement Learning Dimensionality reduction — PCA, LDA, t-SNE, UMAP; Feature selection techniques — filter, wrapper, embedded methods; Hidden Markov Models (HMM); Introduction to Reinforcement Learning — Q-learning, policy, rewards. **[10H]**

Suggested Reading List

1. Russell, S. and Norvig, P., Artificial Intelligence: A Modern Approach, 4th ed., Pearson.
2. Mitchell, T., Machine Learning, McGraw-Hill, 1997.
3. Alpaydin, E., Introduction to Machine Learning, 3rd ed., MIT Press, 2014.
4. Hastie, T., Tibshirani, R., and Friedman, J., The Elements of Statistical Learning, 2nd ed., Springer.
5. Géron, A., Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, O'Reilly.
6. Patterson, D.J., Introduction to Artificial Intelligence and Expert Systems, PHI.
7. Rich, E. and Knight, K., Artificial Intelligence, TMH.

SECOND SEMESTER

Course Code: AIDS-MJR-P-456

Course Category: Major

Course Title: Data Mining and Visualization Laboratory

Prerequisites: Basics of Data Mining

Course Type: Practical

Credit Structure					Marks Distribution			Objective	Course Learning Outcomes
Lecture	Tutorial	Practice	Total Credit	Hours	Summative Assessment	Continuous/ Internal Assessment	Total Marks	To provide practical experience in implementing data mining algorithms and creating effective data visualizations using modern tools and libraries.	- Preprocess and prepare datasets for data mining tasks using Python/R. - Implement association rule mining algorithms (Apriori, FP-Growth) on transactional datasets. - Apply clustering and classification algorithms and evaluate their performance. - Build interactive and informative visualizations using data visualization libraries. - Execute end-to-end data mining projects and interpret results effectively.
0	0	2	2	30	80	20	100		

Laboratory Topics

- Data Loading and Integration:** Load datasets from CSV, Excel, and database sources and integrate multiple datasets using Pandas.
- Data Cleaning and Preprocessing:** Handle missing values, duplicates, outliers, inconsistent data, encoding, scaling, and feature transformation.
- Exploratory Data Analysis:** Perform statistical exploration and identify patterns, relationships, and distributions using Matplotlib, Seaborn, and Plotly.
- Association Rule Mining:** Implement Apriori and FP-Growth to discover frequent itemsets and association rules from transactional datasets.
- Clustering Analysis:** Apply K-Means, hierarchical clustering, and DBSCAN and compare clustering results using appropriate metrics.
- Classification:** Implement Decision Trees, Random Forests, SVM, and Naïve Bayes for supervised classification problems.
- Model Evaluation:** Evaluate models using confusion matrix, accuracy, precision, recall, F1-score, ROC-AUC, and cross-validation.
- Feature Selection and Engineering:** Apply feature selection, dimensionality reduction, and transformation techniques to improve model performance.
- OLAP Analysis:** Perform slice, dice, drill-down, roll-up, and pivot operations on multidimensional datasets using Python.
- Interactive Visualization:** Develop interactive dashboards using Plotly Dash or Tableau to communicate analytical results.
- Text Mining:** Perform text preprocessing, keyword extraction, frequency analysis, sentiment analysis, and word-cloud generation.
- Comparative Analysis:** Compare multiple data mining algorithms based on performance, computational cost, and suitability for different datasets.
- Real-World Case Study:** Analyze a domain-specific dataset and provide data-driven findings and recommendations.
- Integrated Data Mining Pipeline:** Develop a complete workflow combining preprocessing, feature engineering, mining, evaluation, and visualization.
- Mini Project:** Develop an end-to-end data mining solution on a real-world dataset and present the analytical findings through an interactive dashboard.

Suggested Software/Tools: Python, Jupyter Notebook, Google Colab, NumPy, Pandas, Matplotlib, Seaborn, Plotly, Scikit-learn, Mlxtend, NLTK, WordCloud, Plotly Dash, Tableau, and Kaggle/UCI Machine Learning Repository.

SECOND SEMESTER

Course Code: AIDS-MJR-P-457

Course Category: Major

Course Title: Artificial Intelligence and Machine Learning Laboratory **Prerequisites:** Basics concepts of AI/ML

Course Type: Practical

Credit Structure					Marks Distribution			Objective	Course Learning Outcomes
Lecture	Tutorial	Practice	Total Credit	Hours	Summative Assessment	Continuous/ Internal Assessment	Total Marks	To provide practical exposure to AI and machine learning algorithms using Python, reinforcing theoretical understanding through real-world problem solving.	- Implement search algorithms (BFS, DFS, A*) for AI problem solving. - Build and evaluate supervised learning models using scikit-learn. - Apply unsupervised learning algorithms for clustering and dimensionality reduction. - Implement ensemble methods and compare performance across classifiers. - Develop end-to-end ML pipelines with proper preprocessing, model selection, and evaluation.
0	0	2	2	30	80	20	100		

Laboratory Syllabus

- Python Environment Setup:** Install and configure Anaconda, Jupyter Notebook, and essential Python libraries for machine learning.
- Breadth-First and Depth-First Search:** Implement BFS and DFS and analyze their performance on graphs and search problems.
- A* Search Algorithm:** Implement A* using heuristic functions and compare its performance with uninformed search methods.
- Linear Regression:** Implement linear and multiple linear regression and evaluate model performance.
- Logistic Regression:** Develop a logistic regression model for binary and multiclass classification.
- Scikit-learn Pipeline:** Build preprocessing, training, and evaluation pipelines using Scikit-learn.
- Decision Trees:** Implement decision tree classification, visualize the tree, and tune its parameters.
- Random Forest:** Implement Random Forest classification and analyze the effect of hyperparameters on performance.
- K-Means Clustering:** Apply K-Means clustering and determine an appropriate number of clusters using suitable evaluation methods.
- Hierarchical Clustering:** Implement hierarchical clustering and visualize cluster relationships using dendrograms.
- Dimensionality Reduction:** Apply PCA and t-SNE for dimensionality reduction and visualization of high-dimensional datasets.
- Hyperparameter Tuning:** Optimize machine learning models using GridSearchCV and cross-validation.
- XGBoost and Ensemble Methods:** Implement XGBoost and compare its performance with bagging, boosting, and Random Forest methods.
- Model Evaluation and Comparison:** Compare multiple models using accuracy, precision, recall, F1-score, ROC-AUC, and appropriate validation techniques.
- Mini Project:** Develop an end-to-end machine learning pipeline for a real-world domain dataset, including preprocessing, model development, tuning, evaluation, and visualization.

Suggested Software/Tools: Python, Anaconda, Jupyter Notebook, Google Colab, NumPy, Pandas, Matplotlib, Seaborn, Scikit-learn, XGBoost, SciPy, and Plotly.

SECOND SEMESTER

Course Code: AIDS-DISS-458

Course Title: Dissertation-I

Prerequisites:

Course Category: Dissertation

Course Type: Practical (Dissertation)

Credit Structure					Marks Distribution			Objective	Course Learning Outcomes
Lecture	Tutorial	Practice	Total Credit	Hours	Summative Assessment	Continuous/ Internal Assessment	Total Marks	To develop research skills through problem identification, literature review, methodology design, experimentation, and preliminary analysis in an AI and data science domain.	- Identify and formulate a relevant research problem in AI and data science. - Conduct a systematic literature review and identify research gaps. - Design an appropriate methodology and experimental framework. - Implement preliminary experiments and analyze research results. - Prepare and present a research proposal and progress report.
0	0	2	2		-	-	100		

Dissertation-I Activities (Research Proposal and Preliminary Study)

- Research Domain Selection:** Select a research area relevant to Artificial Intelligence and Data Science.
- Problem Identification and Formulation:** Identify a research problem, define its scope, objectives, research questions, and expected contributions.
- Literature Survey:** Conduct a systematic review of relevant books, research papers, datasets, and existing methodologies.
- Research Gap Identification:** Compare existing approaches and identify limitations, gaps, and opportunities for improvement.
- Research Methodology Design:** Develop the proposed research framework, methodology, algorithms, models, and experimental plan.
- Dataset Identification and Preparation:** Identify appropriate datasets and perform data collection, cleaning, preprocessing, and exploratory analysis.
- Baseline Implementation:** Implement suitable existing methods or baseline models for subsequent comparison.
- Preliminary Experimentation:** Conduct initial experiments and evaluate baseline performance using appropriate metrics.
- Research Proposal Preparation:** Prepare a structured proposal containing the problem statement, literature review, research gap, objectives, methodology, and expected outcomes.
- Progress Presentation:** Present the proposed research and preliminary findings before the evaluation committee.

SECOND SEMESTER

Course Code:AIDS-VAC-499A

Course Category: VAC

Course Title: Scientific Writing with LaTeX

Prerequisites:None.

Course Type: Theory+Practice

Credit Structure					Marks Distribution			Objective	Course Learning Outcomes
Lecture	Tutorial	Practice	Total Credit	Hours	Summative Assessment	Continuous/ Internal Assessment	Total Marks	To develop practical skills in scientific writing, LaTeX typesetting, academic formatting, and preparation of professional research documents.	• Explain the fundamentals of scientific writing and LaTeX. • Create structured scientific documents using LaTeX. • Format equations, tables, figures, citations, and bibliographies. • Prepare research papers, reports, and theses using standard templates. • Develop complete scientific documents using LaTeX and collaborative tools.
0	0	0	0	20			100		

Unit 1: Introduction to Scientific Writing and LaTeX: Principles of scientific and technical writing, characteristics of scientific documents, structure of research papers, introduction to LaTeX, installation and online platforms, document classes, document structure, packages, commands, environments, compilation, comments, and basic text formatting. **[4H]**

Unit 2: Document Structure and Mathematical Typesetting: Sections and subsections, title pages, abstracts, paragraphs, lists, footnotes, cross-referencing, mathematical expressions, symbols, equations, aligned equations, matrices, cases, theorem-like environments, and mathematical notation. **[4H]**

Unit 3: Tables, Figures and Scientific Presentation: Creating and formatting tables, multi-column and multi-row tables, captions and labels, inserting and positioning figures, subfigures, diagrams, graphs, floating environments, references to figures and tables, and presentation of scientific results. **[4H]**

Unit 4: Citations, Bibliography and Academic Documents: Citation management, BibTeX and BibLaTeX, bibliography styles, reference databases, DOI and URL handling, citation commands, indexes and glossaries, appendices, preparing manuscripts using journal and conference templates, and avoiding common formatting errors. **[4H]**

Unit 5: Research Paper and Thesis Preparation: Structuring a complete research paper, thesis and project report preparation, page layout and formatting, custom commands, advanced tables and figures, source-code listings, algorithms and pseudocode, presentation of experimental results, collaborative writing using Overleaf, version control concepts, and preparation of a complete scientific document. **[4H]**

Suggested Practical Emphasis

1. Create a basic LaTeX document using appropriate document classes and packages.
2. Format sections, subsections, lists, quotations, footnotes, and references.
3. Typeset mathematical equations, matrices, symbols, and mathematical expressions.
4. Create professional tables using `tabular`, `multirow`, and `multicolumn`.
5. Insert, position, caption, label, and cross-reference figures and subfigures.
6. Manage citations and bibliographies using BibTeX/BibLaTeX.
7. Prepare algorithms, pseudocode, and source-code listings.
8. Format a research paper using an IEEE/ACM/journal template.
9. Prepare a thesis/project report with chapters, appendices, references, figures, and tables.
10. **Mini Project:** Prepare a complete scientific research document in LaTeX, including title, abstract, sections, equations, tables, figures, citations, bibliography, and appendices.

Suggested Software/Tools: Overleaf, LaTeX, TeX Live/MiKTeX, BibTeX/BibLaTeX, JabRef, and Git/GitHub (optional).

SECOND SEMESTER

Course Code:AIDS-VAC-499B

Course Category: VAC

Course Title: Data Analysis on Cloud

Prerequisites: Python Programming and Basic Data Analytics

Course Type: Theory+Practice

Credit Structure					Marks Distribution			Objective	Course Learning Outcomes
Lecture	Tutorial	Practice	Total Credit	Hours	Summative Assessment	Continuous/ Internal Assessment	Total Marks	To develop practical skills in cloud-based data storage, processing, analysis, visualization, and scalable analytics.	- Explain fundamental concepts and architectures of cloud-based data analytics. - Apply cloud platforms for data storage, ingestion, preprocessing, and management. - Perform large-scale data processing using distributed analytics tools. - Develop cloud-based visualizations and dashboards for analytical insights. - Design and implement scalable cloud-based data analytics solutions.
0	0	0	0	20			100		

Unit 1: Introduction to Cloud-Based Data Analytics: Cloud computing concepts, characteristics and service models, cloud deployment models, cloud-based data analytics, cloud data storage, structured and unstructured data, data lakes and data warehouses, cloud analytics architecture, security and privacy considerations, and major cloud platforms. **[4H]**

Unit 2: Cloud Data Storage and Management: Cloud storage concepts, object and file storage, databases as a service, data upload and management, data formats, cloud data ingestion, metadata management, data partitioning, data preprocessing, data integration, and basic cloud security and access control. **[4H]**

Unit 3: Cloud-Based Data Processing: Introduction to distributed data processing, batch and stream processing concepts, Apache Spark fundamentals, Spark DataFrames and SQL, distributed data processing using PySpark, transformations and actions, large-scale data aggregation, and performance considerations. **[4H]**

Unit 4: Cloud Analytics and Visualization: Cloud-based notebooks and analytics environments, exploratory data analysis, statistical analysis, machine learning workflows on cloud platforms, data visualization, interactive dashboards, cloud-based business intelligence, and communicating analytical results. **[4H]**

Unit 5: Scalable Analytics and Applications: Cloud-based machine learning concepts, scalable model training, automated machine learning, data pipelines, workflow orchestration, serverless analytics concepts, monitoring and cost optimization, real-world applications of cloud analytics, and development of an end-to-end cloud analytics solution. **[4H]**

Suggested Practical Emphasis

- Cloud Environment Setup:** Create and configure a cloud-based analytics environment using Google Colab, AWS, Azure, or Google Cloud.
- Cloud Data Storage:** Upload, organize, retrieve, and manage datasets using cloud storage services.
- Data Ingestion:** Import datasets from local files, cloud storage, APIs, and publicly available data sources.
- Cloud-Based Data Preprocessing:** Perform data cleaning, transformation, integration, and feature preparation using Python/Pandas.
- Exploratory Data Analysis:** Perform statistical analysis and visualization of datasets using cloud-based notebooks.
- Cloud-Based Machine Learning:** Develop and evaluate a basic machine learning model using a cloud-based environment.
- Interactive Visualization:** Create interactive charts and dashboards using Plotly, Power BI, Tableau, or equivalent cloud-based tools.
- Data Pipeline Development:** Build a simple pipeline for **data ingestion** → **preprocessing** → **analysis** → **visualization** using cloud services.
- Cloud-Based Analytics Case Study:** Analyze a real-world dataset such as retail, healthcare, finance, IoT, or social media data using cloud resources.
- Scalable Analytics:** Compare local and distributed processing performance using datasets of different sizes.
- Cloud Cost and Resource Analysis:** Examine basic resource utilization, scalability, and cost considerations for cloud-based analytics.
- Mini Project:** Develop an end-to-end cloud-based data analytics solution involving **data ingestion, cloud storage, preprocessing, distributed analysis, visualization, and interpretation**.

Suggested Software/Tools: Google Colab, AWS, Microsoft Azure, Google Cloud Platform, Python, Jupyter Notebook, NumPy, Pandas, PySpark, Apache Spark, Spark SQL, Matplotlib, Seaborn, Plotly, Power BI/Tableau, and Kaggle datasets.