Structure & Syllabus

Department of Computer Science and Applications

School of Mathematical and Physical Sciences
(SMPS)

M.Sc.in Artificial Intelligence & Big Data Analytics

(M.Sc. in AI & BDA)

(Under Self Finance Scheme)

based on

Curriculum Framework

Under NEP-2020

w.e.f.

Academic Session: 2025-2026 and onwards

Date of BoS: 24/04/2024

Doctor Harisingh Gour Vishwavidyalaya, Sagar
(A Central University)
Sagar-Madhya Pradesh 470003

Department of Computer Science and Applications

M.Sc. in Artificial Intelligence and Big Data Analytics under Self Finance Scheme

1. Course Objectives:

M.Sc. in Artificial Intelligence & Big Data Analytics (M.Sc. in AI & BDA) will be a theoretical and practical based program having following objectives:

1.1 To provide students with a deep understanding of fundamental concepts, theories, and methodologies in Artificial Intelligence, Machine Learning, Big data, and Data Analytics.

1.2 To familiarize students with advanced deep learning architectures, algorithms, and frameworks for processing and analyzing big and complex data.

1.3 To introduce students to the principles, algorithms, and applications of artificial intelligence, machine learning for pattern recognition, prediction, and classification tasks.

1.4 To expose students to real-world applications of machine learning and artificial intelligence across various industries, such as healthcare, finance, marketing, and Data analytics.

1.5 To enable students to apply statistical methods and techniques for data exploration, analysis, and inference.

1.6 Analyze and solve problems conceptually and practically from diverse industries, such as government, manufacturing, retail, education, banking/ finance, healthcare and pharmaceutical.

1.7 Undertake consulting projects with significant data analysis component for better understanding of the theoretical concepts from statistics, economics and related disciplines.

1.8 To provide students with hands-on experience in working with big data technologies and platforms for scalable data processing and analysis.

1.9 Use advanced analytical tools/ decision-making tools/ operation research techniques to analyze the complex problems and get ready to develop new techniques for the future.

1.10 To train students in creating effective visualizations and dashboards to communicate insights and findings from data analysis.

1.11 To encourage students to engage in innovative research, explore emerging trends, and contribute to the advancement of knowledge in artificial intelligence and data analytics.

1.12 To prepare students for diverse career opportunities inartificial intelligence, data science, machine learning, data analytics, and related fields through career counselling, networking, and professional development initiatives.

2. Learning Outcome:

After completing this course students shall capable in following:

2.1 Apply AI & Machine Learning techniques to solve real-world problems in various domains, including healthcare, finance, marketing, and others

2.2 Develop a strong foundational understanding of the principles, theories, and concepts underlying Artificial Intelligence and Big Data.

2.3 Attain proficiency in programming languages commonly used in data science and AI, such as Python, R, Spark and gain hands-on experience in implementing algorithms

2.4 Master a broad spectrum of machine learning algorithms, including supervised, unsupervised learning& reinforcement learning, and be able to apply them to solve real-world problems

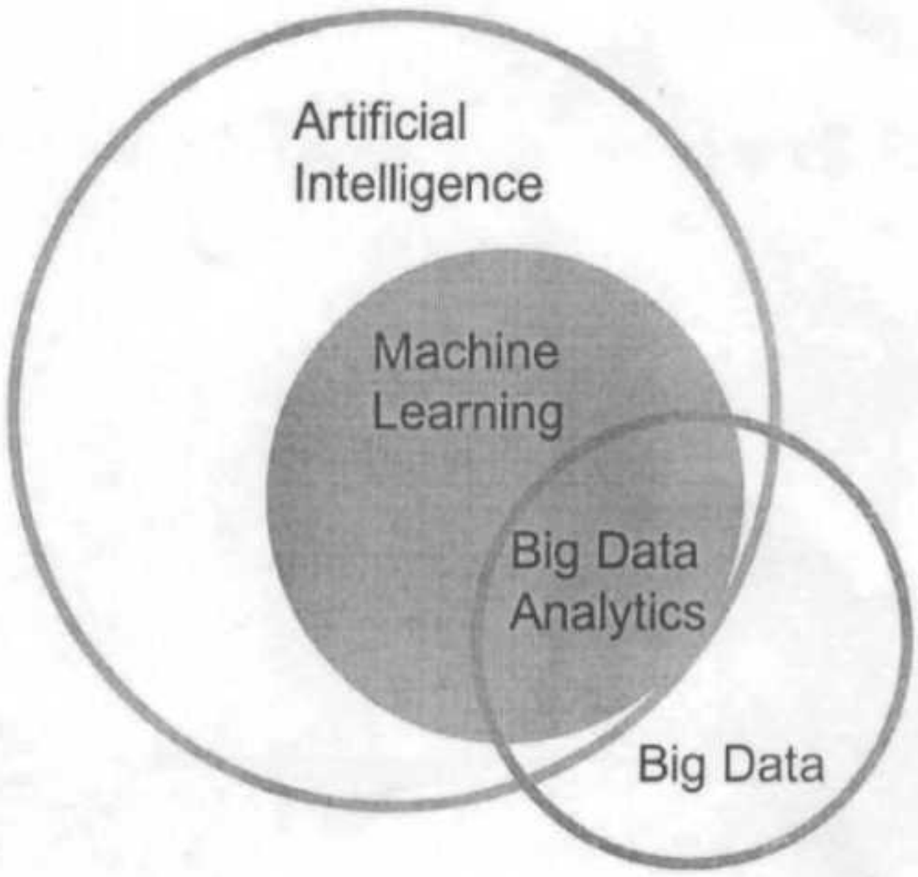
2.5 Develop skills in effectively visualizing and communicating complex data insights to both technical and non-technical stakeholders using tools like Matplotlib, Seaborn, or Tableau

2.6 Big Data Development Familiarization with big data technologies, such as Hadoop, Pig and Hive and learn how to handle and process large-scale datasets efficiently.

2.7 Gain expertise in deep learning techniques, including neural networks and convolutional neural networks, and understand their applications in image recognition, natural language processing, and other domains.

3. Scope of the Course:

The M.Sc. in Artificial Intelligence & Big Data Analytics program trains students to utilize technology effectively for interpreting large volumes of information. Covering artificial intelligence, it teaches students to enable computers to think and learn akin to humans, alongside analyzing extensive datasets to uncover valuable patterns and insights.Students also study techniques like machine learning, deep learning, data mining, and data visualization. With hands-on projects, they gain experience in solving real-world problems in different industries. This program prepares students for careers in artificial intelligence, big data analysis, and machine learning, which are in demand due to recent advancements in A.I.



4. Placement of the Course: The M.Sc. in Artificial Intelligence & Big Data Analytics opens up a wide range of placement opportunities across various industries. Students may explore the following Job profile after completing of this program -

- Data Scientist: Analysing complex datasets to extract insights and drive decision-making processes.
- Machine Learning Engineer: Developing and implementing machine learning algorithms for predictive modelling and pattern recognition.
- AI Engineer: Designing and building artificial intelligence systems and applications.
- Big Data Analyst: Managing and analysing large volumes of data to uncover trends and insights.
- Business Intelligence Analyst: Using data analysis tools to provide strategic insights for business decision-making.
- Data Engineer: Designing, constructing, and maintaining the infrastructure required for data generation and analysis.
- AI Researcher: Conducting research in artificial intelligence to develop innovative solutions and algorithms.
- Data Visualization Specialist: Creating visually appealing representations of data to facilitate understanding and decision-making.
- Cybersecurity Analyst: Using AI and big data analytics to detect and prevent cyber threats.
- Consultant: Providing expert advice on AI and big data strategies for businesses and organizations.

These roles span across industries such as technology, finance, healthcare, retail, marketing, and more. With the increasing demand for professionals skilled in artificial intelligence and big data analytics, graduates of this program have excellent placement opportunities in both established companies and emerging startups.

5. Course Duration: The duration of the course will be of two years (four semesters) and will be functional as per rules and regulation laid down in Ordinance 22(B) of the University.

6. Intake Capacity: There shall be enrolment of maximum of **40 students** in the proposed M.Sc. in AI & BDA program in an academic session 2025-26 and onwards.

7. Reservation Policy: As per the GOI norms

8.Eligibility: Graduate in Science or engineering (B.Sc. /BCA/ B.Voc. or B. Tech. / B.E. / B. Arch.) OR any other relevant degree from recognized University and must have studied mathematicsas a subject in Class 12th standard.

9. Admission Process: Admission process in the course can be initiated in following manner Admissions from the session 2025-2026 onwards in the course M.Sc. in Artificial Intelligence & Big Data Analytics (M.Sc. in AI & BDA) will be through PG-CUET and in case if seats remain

vacant after PG-CUET counseling, the remaining seats may be filled as per the University admission guidelines.

10. Examination System: As per the guidelines of Vishwavidyalaya ordinance 22(A)

- All Programmes of Studies of the University shall be offered under Semester System and Examination and evaluation of students shall be through Comprehensive Continuous Internal Assessment (CCA).
- As a general principle, the Comprehensive Continuous Internal Assessment and End Semester Examination shall comprise the following components:
  i. Mid Term Examination 20%
  ii. Continuous Internal Assessment 20%
  iii. End-Semester Examination 60%
- Depending upon the nature and requirements of a particular course, individual Departments/Centre shall, within the overall framework of Comprehensive Continuous Internal Assessment (CCA) prescribed by the Board of Studies concerned, have freedom to prescribe additional/different components and weightage for different component. Provided that the weightage of the End-Semester Examination shall not be less than 60%.
- Detailed distribution and break-up of the Comprehensive Continuous Internal Assessment (CCA) shall be specified by the teacher concerned in the Detailed Course outlined for each course taught by him/her during a semester.
- The question papers for the End-Semester Examinations shall be of 3 (Three) hours duration and shall be set such as to comprise the following sections:
  i. Section A: shall have 10 (Ten) Objective Type Questions of 1 (one) Mark each. All questions in this Section shall be compulsory (Total 10 Marks)
  ii. Section B: shall have 6 (Six) Short Answer Questions (SAQs) of 5 (Five) Marks each, out of which the examinee shall be required to attempt any (four) questions; (Total 20 Marks)
  iii. Section C: shall have 5 (Five) Essay/Long Answer Questions (LAQs) of 10 marks each. Out of which the examinee shall be required to attempt any three questions (Total 30 Marks);

11. Award of Degree:

(a) Students who clears all the 1 Year (I &II semester) papers of this program, scoring minimum 40% marks in each paper may exit the course as per NEP-2020(after completing formalities mentioned in Ordinance 22(B) and requirement of university) shall be awarded Diploma entitled below:

'POST-GRADUATE DIPLOMA IN ARTIFICIAL INTELLIGENCE & BIG DATA ANALYTICS'

(b) Students who clears all the 2 Year (I, II, III, IV semester) papers of this program, scoring minimum 40% marks in each paper (after completing formalities mentioned in Ordinance 22(B) and requirement of university) shall be awarded Master Degree entitled below:

'M.Sc. in ARTIFICIAL INTELLIGENCE & BIG DATA ANALYTICS'

(c) Student who fails to secure less than 40% in any course paper shall have to repeat the examination of the said course, registering themselves as backlog /re-registration students.

(d) The maximum duration of the course for the award of degree will be as per the rules of ordinance of Vishwavidyalaya.

12. General Instruction:

Wherever the rules shall be found silent, the guidelines or pattern or practices adopted in other similar curses (or PG courses) and as adopted in respective Ordinance of Vishwavidyalaya shall be considered.

12.1 The medium of instruction shall be English (during examination). However lectures may be in Hindi and English both.

12.2 The minimum 50% listed practical must have to be completed by the student before appearing in the End Semester Examination.

12.3 Every student has to attain minimum of 75% of attendance in every course of the program.

12.4 Scheme of Examination:

(a) Mid Semester Examination (ME)	: 20 Marks
(b) Internal Assessment (IA)	: 20 Marks
(c) End Semester Examination (ESE)	: 60 Marks

12.5 Internal Assessment (IA):

(a) Theory: Each theory course shall have the methodology of Internal Assessment using assignment, presentation, group discussion, etc. depending on the number of students in the class and feasibility of adopting a particular methodology. The distribution of marks for internal assessment shall be as follows.

(i) Evaluation of the assignment.	
Presentation, group discussion etc.	: 15 marks
(ii) Attendance	: 05 marks

Note: A student shall be eligible to appear in the End Semester Examination only if he/she has appeared in Mid Semester Examination and in Internal Assessment of the same semester.

(b) Practical/ Lab Courses:

Evaluation of Practical/ Lab Courses shall be as follows:

(i) The practical evaluation of students will be regularly monitored on online platforms like GitHub, Leetcode& others : 15 marks

(ii) Attendance : 05 marks

(c) End Semester Examination for Practical/ Lab Courses:

It will consist of 60 marks as follows:

(a) Assessment of performance in the experiment : 50 Marks

(b) Viva-Voce of Experiment : 10 Marks

12.6 Evaluation of Dissertation/Project:

If the Dissertation/Project is a full paper (course) then its evaluation shall be based on periodic assessment of the progress of the project/Dissertation and End Semester

(i) First periodic assessment of the progress after 08 weeks : 20 Marks

(ii) Second periodic assessment of the progress after 08 weeks : 20 Marks

(iii) End Semester Examination will consist of

a. Evaluation of the project report : 50 Marks

b. Viva Voce of the project report : 10 Marks

12.7 Evaluation of Seminars (other than major projects):

If seminar is a full paper them:

a. Documentation for the seminar : 20 Marks

b. First presentation of the seminar : 20 Marks

c. End Semester Examination : 60 Marks

End Semester Examination will consist:

a. Presentation of the seminar : 50 Marks

b. Defend of the presentation : 10 Marks

12.8 Dissertation Guidelines:

Supervisor: Any faculty appointed in the department of the Computer Science and Applications will be a supervisor for the dissertation/project work. A supervisor will be decided on mutual understanding between students and faculty.

If the dissertation is to be done in a reputed organization, a supervisor from that organization is worked as a principal supervisor and a faculty member from the department as Co-Supervisor.

12.9 The credit and teaching hours shall be distributed as under:

Theory	1- Credit 15 hours / per sem. 2- Credit 30 hours / per sem. 3- Credit 45 hours/ per sem. 4- Credit 60 hours / per sem.
Practical	1- Credit 30 hours / per sem. 2- Credit = 60 hours / per sem.
Tutorial	1- Credit 15 hours / per sem.

Teaching Hours:

*Teaching hours=(Theory course credit * hours + practical course credit * hours)*

Semester I: (20×15) + (4×30) = 420 hours

Semester II: (20×15) + (4×30) = 420 hours

Semester III: (20×15) + (4×30) = 420 hours

Semester IV: 20×15 = 300 hours

12.10 In practical courses students have to maintain a practical file/online coding practices platform which will be regularly evaluated/ monitored by the course In-charge/coordinator.

12.11 The conflict raised, if any, shall be resolved in the meeting of Departmental council or through the guidelines issued by Head of Department.

12.12 A tutorial shall be an interactive session with students and mode of conduct of tutorial shall be decided by concerned teacher/ course-in-charge.

12. Course credit Distribution

Semester	Discipline Specific Major Credit	Multi-Disciplinary Major credit	Skill Enhancement Course Credit	Total
Semester-I	12	6	6	24
Semester-II	12	6	6	24
Semester-III	12	6	6	24
Semester-IV	20	0	0	20

13. Course Structure

Department of Computer Science & Applications
Course Structure as per theCurriculum Framework under National Education Policy(NEP)-2020
Master of Science in Artificial Intelligence & Big Data Analytics (M.Sc. in AI & BDA) - 2 Years (4 Semesters)

Course Structure of M. Sc. in AI & BDA

Semester – I						
Level	**Semester**	**Nature of Course**	**Course Code**	**Course Title**	**MM**	**Credits**
L8	Semester-I	Discipline Specific Major-1	CSA-DSM-121	Programming using R	100	04
			CSA-DSM-122	R Programming Lab	100	02
		Discipline Specific Major-2	CSA-DSM-123	Data Structure & Algorithms	100	04
			CSA-DSM-124	Data Structure & Algorithms Lab	100	02
		Multi-Disciplinary Major-3	CSA-MDM-121	Computational Statistics	100	06
		Skill Enhancement Course	CSA -SEC-121	Artificial Intelligence	100	04
		Skill Enhancement Course	CSA -SEC-122	Seminar/ Presentation	100	02
	Total Credits					**24**

Semester-II						
Level	**Semester**	**Nature of Course**	**Course Code**	**Course Title**	**MM**	**Credits**
L8	Semester-II	Discipline Specific Major-1	CSA -DSM-221	Python Programming	100	04
			CSA -DSM-222	Python Programming Lab	100	02
		Discipline Specific Major-2	CSA -DSM-223	Machine Learning	100	04
			CSA -DSM-224	Machine Learning Lab	100	02
		Multi-Disciplinary Major-3	CSA-MDM-221	Big Data Analytics	100	06
		Skill Enhancement Course	CSA -SEC-221	Cloud Computing & HPC Applications	100	04
		Skill Enhancement Course	CSA -SEC-222	Minor Project	100	02
	Total Credits					**24**
	Exit: PG Diploma in Artificial Intelligence & Big Data Analytics					

Semester-III						
Level	**Semester**	**Nature of Course**	**Course Code**	**Course Title**	**MM**	**Credits**
L9	Semester-III	Discipline Specific Major-1	CSA -DSM-331	Hadoop Programming	100	04
			CSA -DSM-332	Hadoop Programming Lab	100	02
		Discipline Specific Major-2	CSA -DSM-333	Natural Language Processing	100	04
			CSA -DSM-334	Natural Language Processing Lab	100	02
		Multi-Disciplinary Major-3	CSA-MDM-331	Deep Learning	100	06
		Skill Enhancement Course	CSA -SEC-331	Data Analysis & Visualization	100	04
		Skill Enhancement Course	CSA -SEC-332	Seminar/ Presentation	100	02
	Total Credits					**24**

Semester-IV						
Level	**Semester**	**Nature of Course**	**Course Code**	**Course Title**	**MM**	**Credits**
L9	Semester-IV	Discipline Specific Major-1	CSA -DSM-441	Dissertation	100	20
	Total Credits					**20**
	Exit: M.Sc. in Artificial Intelligence & Big Data Analytics					

L = Lecture, T = Tutorial, P = Practical, ME = Mid Examination, IA= Internal Examination, ESE: End Semester Exam.

Note - Students admission at the level L8 & L9 as per the guidelines of curriculum framework under NEP-2020.

Syllabus

M.Sc. in AI& BDA (Semester – I)

Course Code	Course Title	L	T	P	C	Sessional		ESE	Total
						ME	IA		
CSA-DSM-121	Programming using R	04	-	-	04	20	20	60	100

Course Learning Objectives:

1. Develop proficiency in R programming fundamentals and syntax.
2. Construct and manipulate data objects for effective data analysis.
3. Package and deploy R code for efficient sharing and collaboration.
4. Integrate R with external data sources like MySQL and Google Sheets.
5. Enable advanced functionalities such as sending emails directly from R.

Course Learning Outcome:

Upon successful completion of the course, the students

1. Will understand R programming fundamentals including installation, navigation, basic syntax, and accessing help resources.
2. Will understand different data types and data structures, control structures loop control structures and functions.
3. Will developproficiency in importing, exporting, and manipulating data in R, including accessing, sorting, combining, and reshaping data frames.
4. Leverage R's connectivity by integrating with MySQL databases, Google Sheets, and enabling email and efficiently creating manipulating package and deploy R code.
5. Will understand the different types of graph charts and different types of statistical tests.

UNIT-I: Introduction to R programming and RStudio& Installation of R and RStudio, R interpreter,R Basics, Finding Help, Code Editors for R, Command Packages, Manipulating and Processing Data in R.

UNIT– II: Data Objects-Data Types, Introduction to major R data structures like vectors, matrices, arrays, list and data frames, Control Structures, vectorized if and multiple selection, Functions in R (numeric, character, statistical)

UNIT –III: Reading and Getting Data into R, Exporting Data from R, Viewing Named Objects, Structure of Data Items, Manipulating and Processing Data in R (Creating, Accessing , Sorting data frames, Extracting, Combining, Merging, reshaping data frames), Control Structures,

UNIT–IV: Working with objects, Constructing Data Objects, Building R Packages, Running and Manipulating Packages, connecting R to mysql, google sheets in R, sending mail in R.

UNIT –V: Non parametric Tests- ANOVA, chi-Square, t-Test, U-Test, Introduction to Graphical Analysis, Using Plots(Box Plots, Scatter plot, Pie Charts, Bar charts, Line Chart), Plotting variables, Designing Special Plots, Simple Liner Regression, Multiple Regression

Essential Reading:

1. Phillips, N.D. (2018). YaRrr, The Pirate's Guide to R, Version- 0.1.5.
2. Grolemund, G. and Wickham, H. (2023): R for Data Science. https://r4ds.had.co.nz/, 2nd edition

Suggested Reading and links:

1. Mahoney, M. (2024). Introduction to Data Exploration and Analysis with R. version 4.4.0 .
2. https://bookdown.org/mikemahoney218/IDEAR/

ME – Mid – I Exam.; IA – Internal Assessment; ESE – End Semester Exam.

M.Sc. in AI & BDA (Semester – I)

Course Code	Course Title	L	T	P	C	Sessional		ESE	Total
						ME	IA		
CSA-DSM-122	R Programming Lab	-	-	2	2	20	20	60	100

Course Learning Objectives:

1. Develop proficiency in creating and manipulating data objects in R.
2. Build R packages for efficient code organization and sharing.
3. Gain skills in connecting R to databases like MySQL and Google Sheets.
4. Learn to send emails programmatically using R.
5. Apply learned concepts to practical projects for real-world problem-solving.

CourseLearning Outcomes: After completion of this course student will develop proficiency in R programming through hands-on practical application and data analysis.

Based on R programming Lab

1. Read a CSV file into R and display the first few rows of data
2. Generate summary statistics (mean, median, min, max) for a numeric variable in a data frame
3. Convert a data frame column to a factor and display its levels
4. Filter rows of a data frame based on a condition.
5. Merge two data frames based on a common column.
6. Create a bar plot to visualize the frequency of categorical variables.
7. Implement a program that reads a CSV file and displays its content in an HTML table.
8. Use the dplyr package to group data by a variable and calculate summary statistics.
9. Use the ggplot2 package to create a box plot of a numeric variable.
10. Perform data imputation to replace missing values in a data frame.
11. Perform a chi-square test of independence on a contingency table.
12. Perform a t-test to compare two groups in a data frame
13. Write a script to scrape data from a website and store it in a data frame.
14. Create a program to use the reshape2 package to melt and cast a data frame.
15. Implement a file handling script that reads content from one file and writes it to another file in reverse order. Write a script to send an email notification with a summary report of analysis results.

Any other as per teacher concern.

ME – Mid – I Exam.; IA – Internal Assessment; ESE – End Semester Exam.

M.Sc. in AI & BDA (Semester – I)

Course Code	Course Title	L	T	P	C	Sessional		ESE	Total
						ME	IA		
CSA-DSM-123	Data Structure & Algorithms	04	-	-	04	20	20	60	100

Course Learning Objectives:

1. Understand fundamental data structures like arrays, linked lists, stacks, and queues.
2. Learn essential algorithms such as sorting, searching, and graph traversal.
3. Analyze time and space complexity to evaluate algorithm efficiency.
4. Implement advanced data structures like trees, heaps, and hash tables.
5. Apply problem-solving strategies through algorithmic thinking and practice.

Course Learning Outcomes:

Upon successful completion of the course the student will be able:

1. Master fundamental data structures like arrays, linked lists, stacks, and queues.
2. Design and evaluate efficient algorithms for searching, sorting, and traversal.
3. Analyze algorithmic complexity to optimize performance.
4. Apply recursion and dynamic programming for complex problem-solving.
5. Solve real-world problems using data structures and algorithms.

UNIT –I : Linear Data Structures: Introduction - Abstract Data Types (ADT) – Stack – Queue – Circular Queue - Double Ended Queue - Applications of stack – Evaluating Arithmetic Expressions - Other Applications - Applications of Queue - Linked Lists - Singly Linked List - Circularly Linked List - Doubly Linked lists – Applications of linked list.

UNIT –II: Non-Linear Data Structures: Binary Tree – expression trees – Binary tree traversals – applications of trees – Huffman Algorithm - Binary search tree - Balanced Trees - AVL Tree - B-Tree - Splay Trees – Heap- Heap operations- Binomial Heaps - Fibonacci Heaps- Hash set

UNIT –III: Graphs: Graphs terminology, Graph ADT, representations, graph search methods DFS and BFS, Applications of Graphs-Minimum cost spanning tree using Kruskal's algorithm, Dijkstra's algorithm for Single Source Shortest Path Problem.

UNIT –IV: Notion of Algorithm, Growth of functions, Summations, Recurrences: The substitution method, the iteration method, The master method (including proof), Asymptotic Notations Sorting and Searching Techniques.

UNIT –V: Depth first Search, Breadth First Search, Balanced Search trees, Greedy Techniques, Dynamic Programming, Backtracking, n-Queen's Problem.

Essential Reading:

1. Introduction to Algorithms" by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein, Fourth edition, 2022.
2. "Data Structures and Algorithms in Python" by Michael T. Goodrich, Roberto Tamassia, and Michael H. Goldwasser, First edition, 2022.
3. "Algorithms" by Robert Sedgewick and Kevin Wayne.

Suggested Reading:

1. "Data Structures and Algorithm Analysis in C++" by Mark A. Weiss, Fourth edition, 2011.
2. "The Algorithm Design Manual" by Steven S. Skiena, 2nd edition, 2022.

ME– Mid – I Exam.; IA – Internal Assessment; ESE – End Semester Exam.

M.Sc. in AI & BDA (Semester – I)

Course Code	Course Title	L	T	P	C	Sessional		ESE	Total
						ME	IA		
CSA-DSM-124	Data Structure & Algorithms Lab	-	-	02	02	20	20	60	100

Course Learning Objectives:

1. Implement fundamental data structures such as arrays, linked lists, and trees.
2. Analyze algorithmic complexities and optimize code for efficiency.
3. Apply sorting and searching techniques to solve real-world problems.
4. Utilize graph algorithms for solving network-related tasks.
5. Develop problem-solving skills through hands-on coding exercises and projects.

Course Learning Outcome: Develop proficiency in implementing and analyzing fundamental data structures and algorithms through hands-on lab exercises. Gain practical problem-solving skills and the ability to optimize algorithms for efficiency and scalability.

Based on Data Structure & Algorithms Lab

1. Implement a linked list in and perform basic operations like insertion, deletion, and traversal.
3. Write a program to implement a stack using arrays and perform push, pop, and display operations.
4. Create a program to implement a queue using linked lists and perform enqueue, dequeue, and display operations.
5. Implement a binary search tree and perform operations like insertion, deletion, and searching.
6. Write a program in to implement various sorting algorithms like bubble sort, selection sort, and insertion sort.
7. Develop a program to perform binary search on a sorted array.
8. Implement a depth-first search (DFS) algorithm to traverse a graph.
9. Write a program to implement breadth-first search (BFS) on a graph.
10. Create a program to implement dynamic programming for solving the Fibonacci sequence problem.
11. Implement a merge sort algorithm in Java to sort an array of integers.
12. Write a program to implement a priority queue using heaps.
13. Develop a program to implement Dijkstra's algorithm for finding the shortest path in a graph.
14. Implement a hashing technique in to store and retrieve key-value pairs efficiently.
15. Write a program to implement the Knuth-Morris-Pratt (KMP) string searching algorithm.
16. Create a program to perform matrix multiplication using both iterative and recursive approaches.

Any other as per teacher concern.

ME – Mid – I Exam.; IA – Internal Assessment; ESE – End Semester Exam.

M.Sc. in AI & BDA (Semester – I)

Course Code	Course Title	L	T	P	C	Sessional		ESE	Total
						ME	IA		
CSA-MDM-121	Computational Statistics	06	-	-	06	20	20	60	100

Course Learning Objectives:

1. Analyze statistical data using computational methods.
2. Implement advanced statistical techniques in practical applications.
3. Develop proficiency in programming languages like R or Python for statistical analysis.
4. Apply computational tools for data visualization and interpretation.
5. Interpret and communicate results effectively through computational statistics.

Course Learning Outcome:

Upon successful completion of the course, the students

1. Will understand descriptive statistical terms.
2. Will understand probability theory sampling and statistical inference.
3. Will understand concept of probability distribution.
4. Will understand data exploration, regression and correlation analysis.
5. Will understand various concept of hypothesis testing.

UNIT –I: Introduction to Statistics- measures of central tendency-, mean, median, mode, weighted average mean, measures of dispersion, types of dispersion, standard deviation, variation, measures of skewness, Basic probability theory.

UNIT –II: Statistical Concepts - uni-variate and bi-variate sampling, distributions, re-sampling, statistical Inference, prediction error.

UNIT –III: Probability Distribution (Continuous and discrete- Normal, Bernoulli, Binomial, Negative Binomial, Geometric and Poisson distribution) , Bayes' Theorem, Central Limit theorem

UNIT –IV: Data Exploration & preparation, Concepts of Correlation, Regression, Covariance, Outliers etc

UNIT –V: Hypothesis Testing, Hypothesis Testing in Data Analysis, Construction of Confidence Regions and Advanced Concepts.

Essential Reading:

1. "Computational Statistics Handbook with R" by James E. Gentle, Randall W. Merris, and Michael Friendly,1st edition,2017.
2. "Applied Multivariate Statistical Analysis" by Richard A. Johnson and Dean Wichern, sixth Edition,2018.

Suggested Reading and links :

1. "A Student's Guide to R" by Nicholas J. Horton, Daniel T. Kaplan, and Randall P, Edition 1.2, 2015

ME – Mid – I Exam.; IA – Internal Assessment; ESE – End Semester Exam.

M.Sc. in AI & BDA (Semester – I)

Course Code	Course Title	L	T	P	C	Sessional		ESE	Total
						ME	IA		
CSA -SEC-121	Artificial Intelligence	04	-	-	04	20	20	60	100

Course Learning Objectives:

1. Understand foundational concepts of artificial intelligence (AI) and its applications.
2. Explore various AI techniques including machine learning, natural language processing, and computer vision.
3. Develop basic proficiency in implementing AI algorithms and models.
4. Analyze ethical considerations and societal impacts of AI technologies.
5. Apply AI principles to solve real-world problems through hands-on projects and case studies.

Course Learning Outcomes:

Upon successful completion of the course, the students

1. Will grasp the core concepts of AI problems, including the history, foundations
2. Will master various search strategies including BFS, DFS, heuristic search, and game-playing algorithms
3. Will master diverse knowledge representation techniques.
4. Will proficiently apply first-order logic for inference and decision-making
5. Will generate comprehensive understanding of expert systems,.

UNIT –I: AI problems, foundation of AI and history of AI intelligent agents: Agents and Environments, the concept of rationality, the nature of environments, structure of agents, problem solving agents, problem formulation.

UNIT –II: Searching- Searching for solutions, uniformed search strategies – Breadth first search, depth first Search. Search with partial information (Heuristic search) Hill climbing, A*,AO* Algorithms, Problem reduction, Game Playing-Adversial search, Games, mini-max algorithm, optimal decisions in multiplayer games, Problem in Game playing, Alpha-Beta pruning, Evaluation functions.

UNIT –III: Knowledge representation issues, predicate logic- logic programming, semantic nets- frames and inheritance, constraint propagation, representing knowledge using rules, rules based deduction systems. Reasoning under uncertainty, review of probability, Baye's probabilistic interferences and dempstershafer theory.

UNIT –IV: First order logic. Inference in first order logic, propositional vs. first order inference, unification & lifts forward chaining, Backward chaining, Resolution, Learning from observation Inductive learning, Decisiontrees,Explanationbasedlearning, Statistical Learning methods,Reinforcement Learning.

UNIT –V: Structure of expert systems, the human element in expert systems how expert systems works, types of expert systems, , knowledge engineering, machine learning, selecting an appropriate knowledge acquisition method, societal impacts reasoning in artificial intelligence, model based reasoning, case based reasoning, explanation & meta knowledge.

Essential Reading:

1. Stuart Russell and Peter Norvig – Artificial Intelligence A Modern Approach, PEARSON Education, Forth edition, 2022
2. N. P. Padhy – Artificial Intelligence and Intelligence Systems, OXFORD publication. "Artificial Intelligence: Foundations of Computational Agents" by David L. Poole and Alan K. Mackworth, 2nd Edition, 2017
3. Charu C. Aggarwal, Artificial Intelligence: first edition 2022

Suggested Reading and links :

1. "Reinforcement Learning: An Introduction" by Richard S. Sutton and Andrew G. Barto, 2nd Edition,2018.

ME – Mid – I Exam.; IA – Internal Assessment; ESE – End Semester Exam.

M.Sc. in AI & BDA (Semester – I)

Course Code	Course Title	L	T	P	C	Sessional		ESE	Total
						ME	IA		
CSA -SEC-122	Seminar/ Presentation	--	---	---	02	20	20	60	100

Course Learning Objectives:

1. To provide platform for participation by students for academic activities (other than class-room teaching).
2. To explore and enhance capabilities, creativity of students on subject.
3. To provide opportunities to student for additional knowledge, skill, training and higher level academic development.

Course Learning Outcome: After completing this course, student will be strengthen in terms of capabilities, skill, expression, and knowledge other than in curriculum. It will be decided by the department or teacher(s) concern. Students have to participate and earn the credit.

This is activity &participation-based course:

Note:

1. Students have to participate in Seminar, Poster Presentation, Group Discussion, training program, minor project (any three) as decided by course coordinator.
2. Course coordinator will arrange the activities for ME, IA, ESE.
3. A summary of academic content of activity will have to be submitted by students to the course coordinator for mid-term & internal evaluation.
4. There may participation by students in three different (or some similar) activities relating to Mid Exam., assessment and ESEevaluation.
5. There will be individual (or paired) participation of students in each activity.In some cases, group may be considered.

ME – Mid – I Exam.; IA – Internal Assessment; ESE – End Semester Exam.

M.Sc. in AI & BDA (Semester – II)

Course Code	Course Title	L	T	P	C	Sessional		ESE	Total
						ME	IA		
CSA -DSM-221	Python Programming	04	-	-	04	20	20	60	100

Course Learning Objectives:

1. Understand Python syntax and basic programming concepts.
2. Apply Python for data manipulation and analysis.
3. Develop proficiency in creating functions and modules.
4. Explore object-oriented programming principles in Python.
5. Gain practical experience in solving problems using Python.

Unit wise Learning Outcomes:

Upon successful completion of the course, the students

1. Will gain basics understanding of data science and its applications, the basics of data categorization.
2. Will understand concept of database and its storage and will be able to perform various data base queries.
3. Will understand concept of data warehouse its architecture and implementation issues, ETL process and transaction processing
4. Will understand the concept of data mining, its characteristics, benefits, data mining process and privacy issues.
5. Will understand exploratory data analysis and various data manipulation techniques.

UNIT –I: Python – origins – features – variable and assignment - Python basics – statement and syntax – Identifiers – Basic style guidelines – Python objects – Standard types and other built-in types – Internal types – Standard type operators – Standard type built-in functions

UNIT –II: Numbers – Introduction to Numbers – Integers – Double precision floating point numbers – Complex numbers – Operators – Numeric type functions – Sequences: Strings, Lists and Tuples – Sequences – Strings and strings operators – String built-in methods – Lists – List type Built in Methods – Tuples

UNIT- III: Mapping type: Dictionaries – Mapping type operators – Mapping type Built-in and Factory Functions - Mapping type built in methods – Conditionals and loops – if statement – else Statement – elif statement – conditional expression – while statement – for statement – break statement – continue statement – pass statement – Iterators and the iter( ) function - Files and Input/Output – File objects – File built-in functions – File builtin methods – File built-in attributes – Standard files – command line arguments

UNIT- IV: Functions and Functional Programming – Functions – calling functions – creating functions – passing functions – Built-in Functions: apply( ), filter( ), map( ) and reduce( ) - Modules – Modules and Files – Modules built-in functions - classes – class attributes – Instances

UNIT –V: Database Programming – Introduction - Basic Database Operations and SQL - Example of using Database Adapters, Mysql - Regular Expression – Special Symbols and Characters – REs and Python

Essential Reading:

1. Wesley J. Chun Core Python Application Programming Pearson Education Publication, third edition, 2015
2. Eric Matthes Python crash course William Pollock, third edition,2015

Suggested Reading and links :

1. Zed Shaw Learn Python the hard way Addition Wesley, third edition, 2019.
2. Mark Lutz Python pocket reference O'Reilly Media 2014 Pedagogy, fifth edition,2014
3. https://www.codecademy.com/learn/learn-python-3
4. www.spoken-tutorial.org
5. https://docs.python.org/3/tutorial/index.htmlial — Python 3.12.0 documentation

ME – Mid – I Exam.; IA – Internal Assessment; ESE – End Semester Exam.

M.Sc. in AI & BDA (Semester – II)

Course Code	Course Title	L	T	P	C	Sessional		ESE	Total
						ME	IA		
CSA -DSM-222	Python Programming Lab	-	-	02	02	20	20	60	100

Course Learning Objectives:

1. Apply fundamental Python syntax and data structures proficiently.
2. Implement algorithms and solve problems using Python programming constructs.
3. Utilize Python libraries for data manipulation, visualization, and analysis.
4. Develop modular and reusable Python code through functions and classes.
5. Collaborate effectively in a lab environment through code reviews and version control.

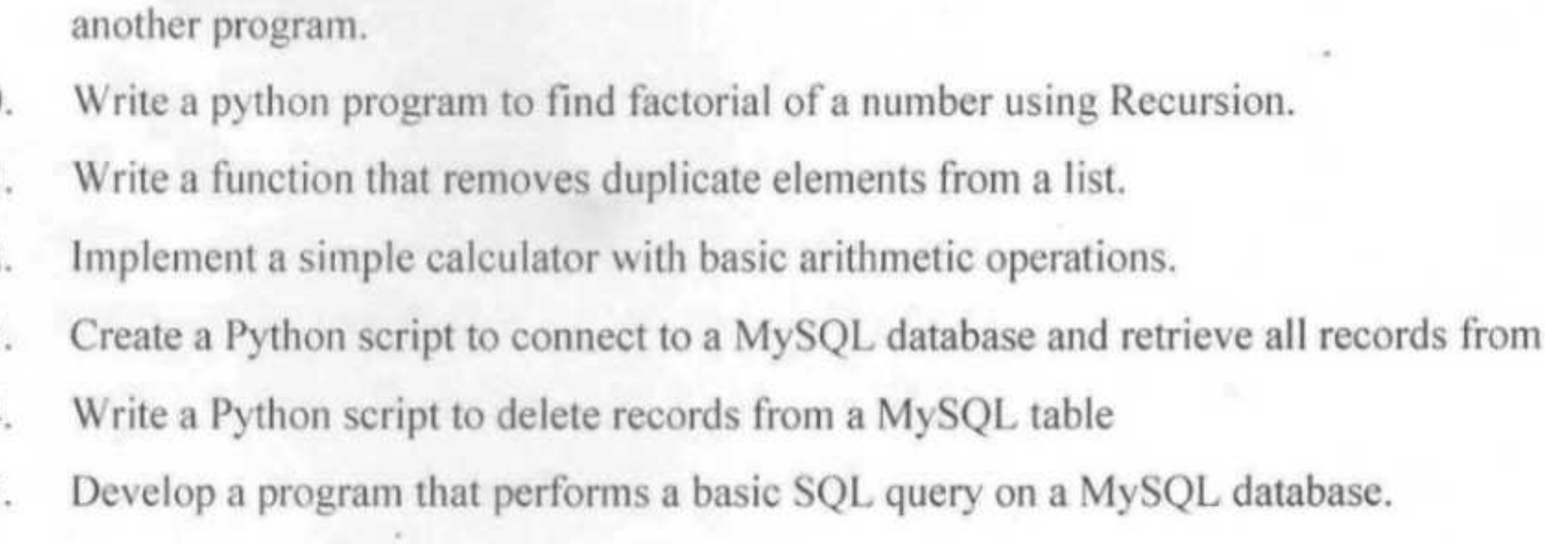
Course Learning Outcome: After completion of this course student will be able to write Python programs on various problems along with their implementation (execution).

Based on Python Programming Lab

1. Write a program to demonstrate different data types in Python.
2. Write a program to perform different Arithmetic Operations on numbers in Python.
3. Write a program to create, concatenate and print a string and accessing sub-string from a given string.
4. Write a program to create, append, and remove lists in python.
5. Write a program to demonstrate working with tuples in python.
6. Write a program to demonstrate working with dictionaries in python.
7. Write a python program to find largest of three number.
8. Write a python program to define a module and import a specific function in that module to another program.
9. Write a python program to define a module to find Fibonacci Numbers and import the module to another program.
10. Write a python program to find factorial of a number using Recursion.
11. Write a function that removes duplicate elements from a list.
12. Implement a simple calculator with basic arithmetic operations.
13. Create a Python script to connect to a MySQL database and retrieve all records from a specific table.
14. Write a Python script to delete records from a MySQL table
15. Develop a program that performs a basic SQL query on a MySQL database.

Any other as per teacher concern.

ME – Mid – I Exam.; IA – Internal Assessment; ESE – End Semester Exam.



M.Sc. in AI & BDA (Semester – II)

Course Code	Course Title	L	T	P	C	Sessional		ESE	Total
						ME	IA		
CSA-DSM-223	Machine Learning	04	-	-	04	20	20	60	100

Course Learning Objectives:

1. Understand foundational concepts of machine learning algorithms.
2. Apply various algorithms for classification and regression tasks.
3. Evaluate model performance and tune hyperparameters effectively.
4. Implement feature engineering techniques for improved model accuracy.
5. Interpret and communicate insights gained from machine learning models.

Course Learning Outcome:

Upon successful completion of the course, the students

1. Will gain a basic understanding of machine learning its types and techniques.
2. Will understand types of clustering methods.
3. Will understand decision trees, classifiers and different types of classifiers.
4. Will understand concept of instant based learning and principal component analysis.
5. Will understand concept of association mining, machine learning in real time, concept of overfitting and underfitting.

UNIT –I: Basics of ML, History of ML, Evolution of ML, ML Models, Learning and testing models, ML Algorithm and Convergence, ML Techniques, Types of ML, supervised, unsupervised learning, Semi-supervised learning and Reinforcement learning,

UNIT –II: Supervised Learning (Regression/Classification): Basic methods: Distancebased methods, Nearest-Neighbours, Decision Trees, Naive Bayes, Linear models: Linear Regression, Logistic Regression, Generalized Linear Models, Support Vector Machines, Nonlinearity and Kernel Methods, Beyond Binary Classification: Multi- class/Structured Outputs, Ranking

UNIT –III: Unsupervised Learning: Clustering: K-means/Kernel K-means, Dimensionality Reduction: PCAand kernel PCA, Matrix Factorization and Matrix Completion, Generative Models (mixture models and latent factor models)

UNIT- IV: Evaluating Machine Learning algorithms and Model Selection, Introduction to Statistical Learning Theory, Ensemble Methods (Boosting, Bagging, Random Forests) ,Overfitting and Underfitting.

UNIT- V: Association rules learning, Apriori and FP-growth, ARIMA, ML in real time.

Essential Reading:

1. " Understanding Machine Learning: From Theory to Algorithms", by Shai Shalev-Shwartz, Shai Ben-David, First edition, 2014.
2. Tom Mitchell, Machine Learning, McGraw-Hill, First Edition, 2017.
3. Charu C. Aggarwal, Machine Learning for Text, second edition 2023

Suggested Reading :

1. Adelchi Data Mining: Practical Machine Learning Tools and Techniques", by Ian H. Witten, Eibe Frank
2. Jiawei Han and Micheline Kamber, "Data Mining: Concepts and Techniques", 3 rd Edition, Morgan Kaufmann Publishers, 2011.
3. Alex Berson and Stephen J. Smith, "Data Warehousing, Data Mining & OLAP", 10th Edition, TataMc Graw Hill Edition, 2007.

ME – Mid – I Exam.; IA – Internal Assessment; ESE – End Semester Exam.

M.Sc. in AI & BDA (Semester – I)

Course Code	Course Title	L	T	P	C	Sessional		ESE	Total
						ME	IA		
CSA-DSM-224	Machine Learning Lab	-	-	2	2	20	20	60	100

Course Learning Objectives

1. Implement fundamental machine learning algorithms in practical scenarios.
2. Apply data preprocessing techniques for model optimization.
3. Evaluate model performance using appropriate metrics.
4. Utilize libraries like scikit-learn or TensorFlow for algorithm implementation.
5. Interpret and communicate results effectively through visualization and analysis.

Course Learning Outcome: After completion of this course student will be able to write programs on various machine Learning problems along with their implementation.

Based on Machine Learning Lab

1. Implement a linear regression model to predict housing prices based on given features.
2. Apply logistic regression for binary classification on a dataset of customer churn prediction.
3. Perform k-means clustering on a dataset of customer segmentation for marketing targeting.
4. Develop a decision tree classifier to predict customer purchase decisions.
6. Apply principal component analysis (PCA) for dimensionality reduction on a high-dimensional dataset.
7. Implement a support vector machine (SVM) for classification on a dataset of handwritten digit recognition.
8. Use random forest for feature importance analysis on a dataset of medical diagnosis.
9. Implement neural network architecture for image classification using the MNIST dataset.
10. Reinforcement learning techniques to train an agent to play a game.
11. Implement a recommendation system using collaborative filtering on a movie rating dataset.
12. Develop a text summarization system using sequence-to-sequence models.
13. Apply reinforcement learning techniques to train an agent to play a game.
14. Perform instance-based learning using k-nearest neighbors (KNN) on a dataset of iris flower classification.
15. Develop a deep learning model for natural language understanding using transformers on a text classification task.
16. Implement K-means clustering algorithm to segment customers based on their purchase history.

Any other as per teacher concern.

ME – Mid – I Exam.; IA – Internal Assessment; ESE – End Semester Exam.

M.Sc. in AI & BDA (Semester – II)

Course Code	Course Title	L	T	P	C	Sessional		ESE	Total
						ME	IA		
CSA-MDM-221	Big Data Analytics	06	-	-	06	20	20	60	100

Course Learning Objectives:

1. To know the fundamental concepts of big data and analytics.
2. To explore tools and practices for working with big data
3. To learn about stream computing.
4. To know about the research that requires the integration of large amounts of data.

Course Learning Outcome:

Upon successful completion of the course, the students

1. Identify the need-based tools, viz., Pig and Hive and to handle and formulate an effective strategy to implement a successful Data analytics project
2. Organize the existing technologies and the need for distributed files systems to analyze the bigdata
3. Analyze the concepts of stream memory and spark models.
4. Explain the use of the NoSQL database in data analytics.

UNIT –I: Evolution of Big data, Best Practices for Big data Analytics, Big data characteristics, Validating, The Promotion of the Value of Big Data, Big Data Use Cases, Characteristics of Big Data Applications, Perception and Quantification of Value, Understanding Big Data Storage, A General Overview of High, Performance Architecture, HDFS, MapReduce and YARN, Map Reduce Programming Model.

UNIT –II: Applications on Big Data Using Pig and Hive, Data processing operators in Pig, Hive services, HiveQL, Querying Data in Hive, fundamentals of HBase and ZooKeeper, IBM InfoSphere Big Insights and Streams

UNIT –III: Advanced Analytical Theory and Methods: Overview of Clustering, K-means, Use Cases - Overview of the Method, Determining the Number of Clusters, Diagnostics, Reasons to Choose and Cautions. Classification: Decision Trees, Overview of a Decision Tree, The General Algorithm, Decision Tree Algorithms, Evaluating a Decision Tree, Decision Trees in R, Naïve Bayes, Baye'sTheorem, Naïve Bayes Classifier

UNIT- IV: Introduction to Streams Concepts, Stream Data Model and Architecture, Stream Computing, Sampling Data in a Stream, Filtering Streams, Counting Distinct Elements in a Stream, Introduction to Spark Concept, Spark Architecture, and components, spark installation, spark RDD(Resilient Distributed Dataset), spark RDD operations

UNIT- V: NoSQL Databases: Schema-less Models: Increasing Flexibility for Data Manipulation, Key-Value Stores, Document Store, Tabular Stores, Object Data Stores, Graph Databases Hive, Sharding, Hbase, Analyzing big data with Twitter, Big data for ECommerce Big data for blogs, Review of Basic Data Analytic Methods using R

Essential Reading:

1. David Loshin, "Big Data Analytics: From Strategic Planning to Enterprise Integration with Tools,Techniques, NoSQL, and Graph", Morgan Kaufmann, first edition, 2013.
2. Chris Eaton, Dirk DeRoos, Tom Deutsch, George Lapis, Paul Zikopoulos, "Understanding Big Data: Analytics for Enterprise Class Hadoop and Streaming Data", McGraw-Hill Publishing, 2012

Suggested Reading:

1. Srinivasan, S., Lavanya, V., & Kumar, *Big Data Analytics: Methods and Applications*. first Edition,2016.
2. Bill Franks,"Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics", John Wiley& sons, first edition, 2013

ME – Mid – I Exam.; IA – Internal Assessment; ESE – End Semester Exam.

M.Sc. in AI & BDA (Semester – II)

Course Code	Course Title	L	T	P	C	Sessional		ESE	Total
						ME	IA		
CSA -SEC-221	Cloud Computing & HPC Applications	04	-	-	04	20	20	60	100

Course Learning Objectives:

1. This course provides a study of Cloud concepts and capabilities across the various Cloud service models including IaaS, PaaS, SaaS, and BPaaS.
2. The course also covers the Cloud security model and associated challenges and delves into the implementation and support of High Performance Computing capabilities on the Cloud.
3. Learn virtualization and parallel computing for efficient resource usage.
4. Master application deployment and optimization for cloud and HPC.
5. Explore emerging trends and challenges in cloud-based HPC.

Course Learning Outcomes:

Upon successful completion of the course, the students

1. Understand the fundamentals of cloud computing architecture and its applications.
2. Learn techniques for optimizing performance and scalability of applications in cloud and HPC settings.
3. Will able to apply fundamental concepts in cloud infrastructures and deploy cloud applications that are resilient, elastic and cost-efficient.
4. Will analyze various cloud programming models and apply them to solve problems on the cloud.

UNIT –I: Introduction to Cloud Computing: Definition, Characteristics, Components, Cloud provider, SAAS, PAAS, IAAS and other Organizational scenarios of clouds, Administering & Monitoring cloud services, benefits and limitations, Deploy application over cloud. Comparison among SAAS, PAAS, IAAS.

UNIT –II: Cloud computing platforms: Infrastructure as service: Amazon EC2, Platform as Service: Google App Engine, Microsoft Azure Utility Computing, Elastic Computing, SLA, clusters, cloud analytics, challenges of cloud environment, HPC in the cloud

UNIT –III: Parallel Processing Concepts: Physical Organization and building blocks of High Performance Computing Systems, Processors and Multi-Core Architectures, Vector processing, Super-scalar, In-order execution, Instruction-Level Parallelism etc., FMA, 32 and 64 bit types, ISA, Accelerators such as GPGPUs and Xeon Phi. Threads and Processes, Multi-processing OS, Parallel I/O, General concepts.

UNIT- IV: Parallel Programming Models and Parallel Algorithms Design: Application domains of HPC, Decomposition Techniques: Data parallelism, Functional parallelism, Divide and Conquer etc

UNIT- V: Installation (Ubuntu and CentOS), Basics of Linux, Configuring Linux, Shells, Commands, and Navigation, Common Text Editors, Administering Linux, Introduction to Users and Groups, Linux shell scripting, shell computing, Introduction to enterprise computing, Remote access.

Essential Reading:

1. Judith Hurwitz, Daniel Kirsch, Cloud Computing for dummies, Wiley publications, second edition, 2020.
2. Igor Faynberg, Hui-Lan Lu, and Dor Skuler, "Cloud Computing: Business Trends and Technologies", first edition, 2017.
3. Erl, T., Puttini, R., & Mahmood, Z. *Cloud Computing: Concepts, Technology & Architecture*. 1st Edition, 2017

Suggested Reading:

1. Cloud Computing Strategies by Dimitris N. Chorafas, first edition, 2019.
2. Cloud Computing Bible by Barrie Sosinsky, first edition,2011.

ME – Mid – I Exam.; IA – Internal Assessment; ESE – End Semester Exam.

M.Sc. in AI & BDA (Semester – II)

Course Code	Course Title	L	T	P	C	Sessional		ESE	Total
						ME	IA		
CSA -SEC-222	Minor Project	-	-	-	02	20	20	60	100

Course Learning Objectives:

1. "Define a clear problem statement or research question pertinent to the chosen field of study, demonstrating a comprehensive understanding of the subject matter."
2. "Design and implement a systematic methodology or approach to address the identified problem, utilizing appropriate tools, techniques, and resources."
3. "Develop and implement a solution or model to address the defined problem, leveraging relevant theories, algorithms, and technologies, and critically evaluating the outcomes."

Course Learning Outcomes:

Upon successful completion of the course, the students

1. Demonstrate the ability to identify and define a problem statement or research question within the chosen domain of study for the minor project.
2. Apply appropriate research methodologies, data collection techniques, and analytical tools to investigate and address the defined problem or question effectively.
3. Develop and implement a well-structured plan to execute the minor project, including timelines, resource allocation, and milestones for monitoring progress.

Guidelines:

Overview: Every student should do a dissertation individually or in some cases, it may be in a group of two students. The type of dissertation can be either application-oriented with the latest technologies or resèarch-based.

Supervisor: Any faculty appointed in the department of the Computer Science and Applications will be a supervisor for the dissertation work. A supervisor will be decided on mutual understanding between students and faculty.

Platform: The dissertation can be on any platform e.g., WINDOWS, UNIX, LINUX, Mac OS, etc. The dissertation can be done using any language or package learned within or outside the course such as C, C++, Java, .NET, Python, etc.

Venue: The dissertation can be done in the University itself or in a reputed organization/ITcompany.

Mid-I and Internal Assessment: The progress of the dissertation will be evaluated as Mid-I and internal assessment through seminar/presentation, write-up/synopsis/ progress report.

Final Examination: For the final external evaluation a brief summary of the project in the form of hard and soft copy report along with the developed codes, output, results, software, hardware (as applicable) etc. should be submitted to the university at least one week prior to the date of the examination for the benefit of the external examiner

ME – Mid – I Exam.; IA – Internal Assessment; ESE – End Semester Exam.

M.Sc. in AI & BDA (Semester – III)

Course Code	Course Title	L	T	P	C	Sessional		ESE	Total
						ME	IA		
CSA -DSM-331	Hadoop Programming	04	-	-	04	20	20	60	100

Course Learning Objectives:

1. Understand the fundamentals of distributed computing and the MapReduce paradigm as applied in Hadoop.
2. Gain proficiency in setting up, configuring, and managing Hadoop clusters for storing and processing large-scale datasets.
3. Develop skills in writing MapReduce programs and executing them on Hadoop clusters to perform data processing tasks efficiently.
4. Explore advanced data processing techniques and algorithms using Apache Spark, including RDDs, DataFrames, and Spark SQL

Course Learning Outcomes:

Upon successful completion of the course, the students

1. Will have proficiency in leveraging Hadoop's distributed file system (HDFS) and MapReduce paradigm to efficiently process and analyze large-scale datasets.
2. Will be able to apply advanced techniques in Hadoop ecosystem components such as Hive, Pig, and HBase for data querying, processing, and storage.
3. Will be able to utilize Apache sqoop to develop program to ingest data to HDFS.

UNIT –I: Introduction of Hadoop, the ecosystem and stack, Components of Hadoop, Hadoop Distributed File System (HDFS). Architecture overview, Development Environment, Hadoop distribution and basic commands, The HDFS command line and web interfaces, Analyzing the Data with Hadoop, Scaling Out, Hadoop event stream processing, complex event processing,

UNIT –II: Map Reduce Introduction, developing a Map Reduce Application, How Map Reduce Works, Anatomy of a Map Reduce Job run, Failures, Job Scheduling, Shuffle and Sort, Task execution, Map Reduce Types and Formats, Map Reduce Features. Hadoop ETL: Hadoop ETL Development, ETL Process in Hadoop, need of ETL tools, Advantages of ETL tools

UNIT –III: Hadoop Ingestion Tools: Sqoop Features, Sqoop architecture, Installing Mysql, Install and configure Sqoop on cluster, Connecting to RDBMS, Import data from Mysql to hive, Export data to Mysql, Hive Import ..

UNIT- IV: Introduction to Pig and HIVE- Programming Pig: Engine for executing data flows in parallel on Hadoop, Programming with Hive: Data warehouse system for Hadoop, Hive architecture, Optimizing with Combiners and Partitioners (lab), Different type of tables in hive, buckets, partions, Joins in hive. Hbase. Pig basics, Pig Latin scripts, Modes of running PIG, Grunt shell.

UNIT- V: - Introduction to Streams Concepts, Stream Data Model and Architecture, Stream Computing, Sampling Data in a Stream, Filtering Streams, Counting Distinct Elements in a Stream, Introduction to Spark Concept, Spark Architecture, and components, spark installation, spark RDD(Resilient Distributed Dataset), spark RDD operations

Essential Reading:

1. "Hadoop for Dummies", by Ellis by Dirk deRoos, et al., 1st Edition,2014
2. "Practical Hadoop Ecosystem: A Definitive Guide to Hadoop-Related Frameworks and Tools" by Deepak Vohra, 1st Edition,2016

Suggested Reading:

1. Big Data and Hadoop: Learn by Example by Mayank Bhushan, Kindle Edition,2020
2. "Learning Spark: Lightning-Fast Big Data Analysis" by Holden Karau, Andy Konwinski, Patrick Wendell, and Matei Zaharia, First Edition, 2015.

ME – Mid – I Exam.; IA – Internal Assessment; ESE – End Semester Exam.

M.Sc. in AI & BDA (Semester – III)

Course Code	Course Title	L	T	P	C	Sessional		ESE	Total
						ME	IA		
CSA -DSM-332	Hadoop Programming Lab		-	02	02	20	20	60	100

Course Learning Objectives:

1. Gain proficiency in setting up and configuring Hadoop and Spark environments for distributed data processing.
2. Acquire practical skills in developing MapReduce programs to process large-scale datasets efficiently in the Hadoop ecosystem.
3. Master the fundamentals of Spark programming, including RDDs (Resilient Distributed Datasets) and transformations/actions, for parallel data processing.
4. Explore advanced Spark features such as Spark SQL, DataFrame API, and machine learning libraries for performing complex analytics tasks

Course Learning Outcomes: After completion of this course student will be able to write programs on various problems in Hadoop, Pig, Hive, Spark along with their implementation.

Based on Hadoop Programming Lab

1. Implement the classic word count example using MapReduce in Hadoop to count the occurrences of each text
2. PageRank algorithm implementation for web page ranking in a large dataset.
3. K-means clustering algorithm to group similar data points in a distributed manner.
4. Distributed grep program to search for specific patterns across multiple files.
5. Distributed cache implementation to share small, read-only files among nodes efficiently.
6. Data cleaning script in Pig to remove duplicates and filter out irrelevant records.
7. ETL process in Pig to extract, transform, and load data from various sources into a structured format.
8. Join operation in Pig to combine data from multiple datasets based on common keys.
9. User-defined function (UDF) in Pig to perform custom processing on data within Pig scripts.
10. Script in Pig to calculate aggregate statistics such as mean, median, and mode on large datasets.
11. SQL-like queries in Hive to perform data analysis and reporting on structured data stored in Hadoop.
12. Partitioning tables in Hive based on date or other categorical variables for efficient querying.
13. External table creation in Hive to reference data stored outside of the Hive warehouse directory.
14. Complex joins and subqueries in Hive to combine data from multiple tables for analysis.
15. Word count program using Spark RDDs for distributed text processing.

Any other as per teacher concern.

ME – Mid – I Exam.; IA – Internal Assessment; ESE – End Semester Exam.

M.Sc. in AI & BDA (Semester –III)

Course Code	Course Title	L	T	P	C	Sessional		ESE	Total
						ME	IA		
CSA -DSM-333	Natural Language Processing	04	-	-	04	20	20	60	100

Course Learning Objectives:

1. Understand NLP fundamentals and applications.
2. Learn text preprocessing techniques.
3. Explore text representation methods.
4. Master common NLP tasks.
5. Apply advanced NLP models for language tasks.

Unit wise Learning Outcomes:

Upon successful completion of the course, the students

1. will understand NLP basics: tokenization, stemming, lemmatization.
2. will analyze text for tasks like named entity recognition and sentiment analysis.
3. Able to implement models like word embeddings and sequence-to-sequence.
4. will be able to explore advanced tasks such as text summarization and machine translation.
5. will apply NLP techniques to real-world problems effectively. .

UNIT –I: Understanding Language, NLP Overview, Definition, History and Challenges, NLP Applications, Language, as a rule, Artificial language (Logical language/programming language) vs. Natural Language, Language Modelling, Grammar-based Language Models, Statistical Language Models, Description of different branches of Linguistics: Statistical Linguistics, Psycholinguistics, Neurolinguistics, Computational Linguistics, Sociolinguistics.

UNIT –II: Simple N-gram models. Estimating parameters and smoothing. Evaluating language models, Semantics, Discourse, Pragmatics, Part of Speech Tagging,Lexical syntax. Hidden Markov Models

UNIT –III: Parsing and Analysis: Syntactic parsing, Semantic Analysis, Lexical semantics, and word-sense disambiguation. Tools for NLP: Introduction to NLTK, NLP with Machine Learning and Deep Learning, Word2Vecmodels, Language modeling using Naive Bayes Maximum entropy classifiers and their application to document classification.

UNIT- IV: Lexical knowledge networks, wordnet theory, Indian languages wordnet, multilingual dictionaries, semantic roles, word sense disambiguation, metaphors

UNIT-V: NLP Model Deployment Techniques using Flask, Information Extraction, Machine Translation. Sentiment Analysis, text entailment, robust and scalable machine translation, question answering, multilingual setting, cross-lingual information retrieval.

Essential Reading:

1. Jurafsky & Martin, "Speech and Language Processing", Pearson Publication, second edition, 2018.
1. Sue Knight, NLP at Work, Nicholas Brealey Publishing, second edition, 2018.

Suggested Reading and links :

2. Deepti Chopra, Jacob Perkins, and Nitin Hardeniya, "Natural Language Processing: Python and NLTK", second edition, 2017.
3. GARG M., "Natural Language Processing And Information Retrieval Principles And Applications", first edition 2024.

ME – Mid – I Exam.; IA – Internal Assessment; ESE – End Semester Exam.

M.Sc. in AI & BDA (Semester – III)

Course Code	Course Title	L	T	P	C	Sessional		ESE	Total
						ME	IA		
CSA -DSM-334	Natural Language Processing Lab	--	-	02	02	20	20	60	100

Course Learning Objectives:

1. Understand fundamental concepts of digital image processing and computer vision.
2. Apply various image processing techniques for enhancement, segmentation, and feature extraction.
3. Develop skills in implementing computer vision algorithms for tasks like object detection, recognition, and tracking.
4. Explore deep learning approaches for image analysis and understand their applications in computer vision.
5. Gain practical experience through hands-on projects to solve real-world problems in digital image processing and computer vision.

Course Learning Outcomes: After completion of this course student will be able to write programs on various Digital Image Processing & Computer Vision concept along with their implementation.

Based on Natural Language Processing Lab

1. Tokenize a sentence into words using Python.
2. Perform stemming on a set of words using NLTK or spaCy.
3. Remove stop words from a text document in Python.
4. Conduct part-of-speech tagging on a sentence using NLTK or spaCy.
5. Implement named entity recognition (NER) in Python.
6. Develop a sentiment analysis classifier using pre-trained models.
7. Perform text summarization using extractive techniques.
8. Create a simple chatbot using NLTK or spaCy.
9. Build a text classification system using machine learning algorithms.
10. Perform topic modeling to identify latent topics in a document collection.
11. Generate text using recurrent neural networks (RNNs) or transformer-based models.
12. Implement a language translation system using machine translation models.
13. Extract key phrases or keywords from a text document.
14. Conduct dependency parsing on a sentence using spaCy or StanfordNLP.
15. Develop a sentiment analysis web application using Flask or Django.

Any other as per teacher concern.

ME – Mid – I Exam.; IA – Internal Assessment; ESE – End Semester Exam.

M.Sc. in AI & BDA (Semester – III)

Course Code	Course Title	L	T	P	C	Sessional		ESE	Total
						ME	IA		
CSA-MDM-331	Deep Learning	06	-	-	06	20	20	60	100

Course Learning Objectives:

1. Master deep learning fundamentals.
2. Implement models using TensorFlow and PyTorch.
3. Explore CNNs and RNNs.
4. Train models for image, text, and generative tasks.
5. Evaluate and troubleshoot model performance

Course Learning Outcomes:

Upon successful completion of the course, the students

1. Will be able to apply deep learning principles effectively.
2. Will be able to implement advanced neural network architectures.
3. Will be able to Optimize model performance and interpret results.
4. Utilize CNNs, RNNs, and GANs for various applications.
5. Address ethical considerations in deep learning deployment.

UNIT –I: Introduction to Deep Learning: Definition, Applications, Neural Networks, Machine Learning vs Deep Learning, Deep Learning Libraries (Tensorflow, Keras, PyTorch), Types (Supervised Learning, Unsupervised Learning, Reinforcement Learning) and their Comparison. Datasets: Numerical Data, Categorical Data, Data Quality, Data Remediation, Data Preprocessing (Dimensionality Reduction, Feature Transformation, Feature Subset Selection)

UNIT –II: Neural Networks: Basics, Types, Intuitions, Neurons, Kernels, Biases, Weights, Initialization, Gradient Descent, Heuristics, Training (Holdout Method, K-Fold Cross-Validation Method, Bootstrap Sampling, Lazy vs Eager Learner), Evaluation (Regression, Classification and Clustering), Perceptrons, Derivatives, Computation graph, Vectorization, Broadcasting, Propagation (Forward and Back), Parameters vs Hyperparameters

UNIT- III: Deep Feedforward Network: Feed-forward Networks, Gradient-based Learning, Hidden Units, Architecture Design, Computational Graphs, BackPropagation, Regularization, Parameter Penalties, Data Augmentation, Multitask Learning, Bagging, Dropout and Adversarial Training and Optimization

UNIT- IV: Convolution Networks: Convolution Operation, Pooling, Basic Convolution Function, Convolution Algorithm, Unsupervised Features and Neuroscientific for convolution Network..

UNIT –V: Sequence Modelling: Recurrent Neural Networks (RNNs), Bidirectional RNNs, Encoder Decoder Sequence-to-Sequence Architectures, Deep Recurrent Network, Recursive Neural Networks and Echo State networks.

Essential Reading:

1. Goodfellow L., Bengio Y. and Courville A., —Deep Learning, MIT Press, 2016.
2. Patterson J. and Gibson A., —Deep Learning: A Practitioner's Approachl, O'Reilly, first Edition, 2017
3. Haykin S., —Neural Network and Machine Learning, Prentice Hall Pearson 3rd Edition, 20019.

Suggested Reading and links:

4. Charu C. Aggarw, Neural Networks and Deep Learning, first Edition, 2018

ME – Mid – I Exam.; IA – Internal Assessment; ESE – End Semester Exam.

M.Sc. in AI & BDA (Semester –I II)

Course Code	Course Title	L	T	P	C	Sessional		ESE	Total
						ME	IA		
CSA -SEC-331	Data Analysis & Visualization	04	-	-	04	20	20	60	100

Course Learning Objectives:

1. Understand data analysis fundamentals: cleaning, transformation, and exploration.
2. Apply statistical techniques for data summarization and interpretation.
3. Master visualization for effective communication of insights.
4. Develop skills in exploratory data analysis (EDA) and hypothesis testing.
5. Gain proficiency in data analysis and visualization software.

Unit wise Learning Outcomes:

Upon successful completion of the course, the students

1. Will Master data cleaning, statistical analysis, and visualization.
2. Will be able to create insightful visuals and reports.
3. Will be able to use EDA to find patterns.
4. Will able to generate and communicate results effectively using Tableau.

UNIT –I: Information Visualization, Data analytics Life Cycle, Analytic Processes and Tools, Analysis vs. Reporting. Creating reports in R

UNIT –II: Modern Data Analytic Tools, Visualization Techniques, Visual Encodings, Visualization algorithms. Shiny dashboard.

UNIT –III: Data collection and binding, Cognitive issues, Interactive visualization.

UNIT- IV: Visualizing big data – structured vs unstructured, Visual Analytics, Geo-mapping, Dashboard Design.

UNIT- V:Data Visualization using Tableau.

Essential Reading:

1. "The Visual Display of Quantitative Information" by E. Tufte, second edition, 2001
2. "The Wall Street Journal Guide to Information Graphics: The Dos and Don'ts of Presenting Data, Facts, and Figures" by Dona M. Wong, et al. , reprint edition, 2014.

Suggested Reading and links:

1. "Information Dashboard Design: Displaying Data for At-a-Glance Monitoring" by Stephen Few.,second edition, 2013.
2. Jack A. Hyman et. Al. Data Analytics & Visualization All-in-One For Dummies, first edition, 2024

ME – Mid – I Exam; IA – Internal Assessment; ESE – End Semester Exam.

M.Sc. in AI & BDA (Semester –III)

Course Code	Course Title	L	T	P	C	Sessional		ESE	Total
						ME	IA		
CSA -SEC-332	Seminar/ Presentation	--	---	---	02	20	20	60	100

Course Learning Objectives:

1. To provide platform for participation by students for academic activities (other than class-room teaching).
2. To explore and enhance capabilities, creativity of students on subject.
3. To provide opportunities to student for additional knowledge, skill, training and higher level academic development.

Course Outcome: After completing this course, student will bestrengthen in terms of capabilities, skill, expression, and knowledge other than in curriculum. It will be decided by the department or teacher(s) concern. Students have to participate and earn the credit.

This is activity &participation-based course:

Note:

1. Students have to participate in Seminar, Poster Presentation, Group Discussion, training program, minor project (any three) as decided by course coordinator.
2. Course coordinator will arrange the activities for ME, IA, ESE.
3. A summary of academic content of activity will have to be submitted by students to the course coordinator for mid-term & internal evaluation.
4. There may participation by students in three different (or some similar) activities relating to Mid Exam., assessment and ESEevaluation.
5. There will be individual (or paired) participation of students in each activity.In some cases group may be considered.

ME – Mid – I Exam.; IA – Internal Assessment; ESE – End Semester Exam.

M.Sc. in AI & BDA (Semester – IV)

Course Code	Course Title	C	L	T	P	Sessional		ESE	Total
						ME	IA		
CSA -DSM-441	Dissertation	20	-	-	-	20	20	60	100

Course Learning Objectives:

1. "Define a clear problem statement or research question pertinent to the chosen field of study, demonstrating a comprehensive understanding of the subject matter."
2. "Design and implement a systematic methodology or approach to address the identified problem, utilizing appropriate tools, techniques, and resources."
3. "Develop and implement a solution or model to address the defined problem, leveraging relevant theories, algorithms, and technologies, and critically evaluating the outcomes."

Course Learning Outcomes:

Upon successful completion of the course, the students

1. Demonstrate the ability to identify and define a problem statement or research question within the chosen domain of study for the minor project.
2. Apply appropriate research methodologies, data collection techniques, and analytical tools to investigate and address the defined problem or question effectively.
3. Develop and implement a well-structured plan to execute the minor project, including timelines, resource allocation, and milestones for monitoring progress.

Guidelines:

Overview: Every student should do a dissertation individually or in some cases, it may be in a group of two students. The type of dissertation can be either application-oriented with the latest technologies or research-based.

Supervisor: Any faculty appointed in the department of the Computer Science and Applications will be a supervisor for the dissertation work. A supervisor will be decided on mutual understanding between students and faculty.

If the dissertation is to be done in a reputed organization, a supervisor from that organization is worked as a principal supervisor and a faculty member from the department as Co-Supervisor.

Platform: The dissertation can be on any platform e.g., WINDOWS, UNIX, LINUX, Mac OS, etc. The dissertation can be done using any language or package learned within or outside the course such as, Python, R, Hadoop, Spark etc.

Venue: The dissertation can be done in the University itself or in a reputed organization/ITcompany.

Note: if student carried his/her dissertation outside Sagar they may be exempted from mandatory attendance.

Mid-I and Internal Assessment: The progress of the dissertation will be evaluated as Mid-I and internal assessment through seminar/presentation, write-up/synopsis/ progress report.

Final Examination: For the final external evaluation, a brief summary of the dissertation in the form of hard and soft copy report along with the developed codes, output, results, software, hardware (as applicable) etc. should be submitted to the university at least one week prior to the date of the examination for the benefit of the external examiner.

ME – Mid – I Exam.; IA – Internal Assessment; ESE – End Semester Exam.