Anekant Education Society's

Tuljaram Chaturchand College

of Arts, Science and Commerce, Baramati

(Autonomous)

M.Sc. Degree Program in Data Science

(Faculty of Science & Technology)

CBCS Syllabus

M.Sc. (Data Science) Part – II Semester – IV

For Department of Statistics

Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati

Choice Based Credit System Syllabus (2023 Pattern)

(As Per NEP 2020)

To be implemented from Academic Year 2024-2025

Program Outcomes for M.Sc.

PO1. Comprehensive Knowledge and Understanding:

Postgraduates will possess a profound understanding of their field, encompassing foundational theories, methodologies, and key concepts within a multidisciplinary context.

PO2. Practical, Professional, and Procedural Knowledge:

Postgraduates will acquire practical skills and expertise necessary for professional tasks, including industry standards, regulations, and ethical considerations, with effective application in real-world scenarios.

PO3. Entrepreneurial Mindset, Innovation, and Business Understanding:

Postgraduates will cultivate an entrepreneurial mindset, identify opportunities, foster innovation, and understand business principles, market dynamics, and risk management strategies.

PO4. Specialized Skills, Critical Thinking, and Problem-Solving:

Postgraduates will demonstrate proficiency in technical skills, analytical abilities, effective communication, and leadership, adapting and innovating in response to changing circumstances.

PO5. Research, Analytical Reasoning, and Ethical Conduct:

Postgraduates will exhibit observational and inquiry skills, formulate research questions, utilize appropriate methodologies for data analysis, and adhere to research ethics while effectively reporting findings.

PO6. Communication, Collaboration, and Leadership:

Postgraduates will effectively communicate complex information, collaborate in diverse teams, demonstrate leadership qualities, and facilitate cooperative efforts toward common goals.

PO7. Digital Proficiency and Technological Skills:

Postgraduates will demonstrate proficiency in using ICT, accessing information sources, analyzing data using appropriate software, and adapting to technological advancements.

PO8. Multicultural Competence, Inclusive Spirit, and Empathy:

Postgraduates will engage effectively in multicultural settings, respect diverse perspectives, lead diverse teams, and demonstrate empathy and understanding of others' perspectives and emotions.

PO9. Value Inculcation, Environmental Awareness, and Ethical Practices:

Postgraduates will embrace ethical and moral values, practice responsible citizenship, recognize and address ethical issues, and promote sustainability and environmental conservation.

PO10. Autonomy, Responsibility, and Accountability:

Postgraduates will apply knowledge and skills independently, manage projects effectively, and demonstrate responsibility and accountability in work and learning contexts, contributing to societal well-being.

Anekant Education Society's

Tuljaram Chaturchand College, Baramati

(Autonomous)

Board of Studies (BOS) in Statistics

From 2022-23 to 2024-25

Sr. No.	Name	Designation
1.	Prof. Dr. Vikas C. Kakade	Chairman
2.	Prin. Dr. Avinash S. Jagtap	Member
3.	Dr. Neeta K. Dhane	Member
4.	Dr. Vaishali V. Patil	Member
5.	Mrs. Sarita D. Wadkar	Member (Ad hoc)
6.	Mr. Chandrashekhar P. Swami	Member
7.	Ms. Priti M. Mohite	Member (Ad hoc)
8.	Ms. Nilambari A. Jagtap	Member (Ad hoc)
9.	Miss. Kalyani C. Kale	Member (Ad hoc)
10.	Ms. Pooja S. Zanjurne	Member (Ad hoc)
11.	Dr. Akanksha S. Kashikar	Vice-Chancellor Nominee
12.	Prin. Dr. Rajendra G. Gurao	Expert from other University
13.	Mr. Rohan Koshti	Expert from other University
14.	Mr. Saurabh Kadam	Industry Expert
15.	Dr. Jaya L. Limbore	Meritorious Alumni
16.	Miss. Priya N. Rakate	Invitee Member
17.	Ms. Ankita G. Deshmukh	Invitee Member
18.	Ms. Shital B. Choudhar	Invitee Member

19.	Miss. Kiran Banda (M.Sc. II)	Student Representative
20.	Mr. Rushikesh Pandhare (M.Sc. II)	Student Representative
21.	Mr. Bharat Jambhulkar (TYBSc)	Student Representative
22.	Miss. Prapti Mane (TYBSc)	Student Representative

Credit Distribution Structure for M.Sc. (Data Science) Part-I

Level	Semester	Major		Research Methodology (RM)	OJT/FP	RP	Cum. Cr.	Degree
		Mandatory	Electives					
6.0	Sem-I	DSC-501-MJM: Probability Distributions (Credit 04) DSC-502-MJM: Statistical Inference (Credit 04) DSC -503-MJM: Data Science Practical – I (Credit 02) DSC-504-MJM: Data Science Practical – II (Credit 02)	DSC-511-MJE (A): Data Base Management System DSC -511-MJE (B): Stochastic Models and Applications (Credit 04)	DSC -521-RM: Research Methodology (Credit 04)	--	--	**20**	PG Diploma (after 3 Year Degree)
	Sem-II	DSC -551-MJM: Design and Analysis of Experiments (Credit 04) DSC-552-MJM: Regression Analysis and Predictive Models (Credit 04) DSC-553-MJM: Data Science Practical – III (Credit 02) STA -554-MJM: Data Science Practical – IV (Credit 02)	DSC -561-MJE (A): Bayesian Inference DSC -561-MJE (B): Computational Statistics (Credit 04)	--	DSC-581-OJT/FP: On Job Training/ Field Project	--	**20**	

Credit Distribution Structure for M.Sc. (Data Science) Part-II

Level	Semester	Major		Research Methodology (RM)	OJT /FP	RP	Cum. Cr.	Degree
		Mandatory	Electives					
6.5	Sem-III	DSC-601-MJM: Exploratory Multivariate Data Analysis (Credit 04)	DSC-611-MJE(A): Machine Learning (Credit 02)	--	--	DSC-621-RP: Research Project (Credit 04)	**20**	PG Diploma (after 3 Year Degree)
		DSC-602-MJM: Time Series Analysis and Forecasting (Credit 04)	DSC-611-MJE(B): Text Mining and Natural Language Processing (Credit 02)					
		DSC-503-MJM: Statistics Practical – V (Credit 02)	DSC-612-MJE(A): Machine Learning: Techniques and Applications (Credit 02)					
		DSC-504-MJM: Statistics Practical – VI (Credit 02)	DSC-612-MJE(B): Practical Based on Text Mining and NLP (Credit 02)					
	Sem-IV	DSC-651-MJM: Artificial Intelligence (Credit 04)	DSC-661-MJE (A): Supply Chain and Logistics Analytics (Credit 02)	--	--	DSC-621-RP: Research Project (Credit 06)	**20**	
		DSC-652-MJM: Deep Learning (Credit 04)	DSC-661-MJE(B): Discrete Data Analysis (Credit 02)					
		DSC-653-MJM: Data Science Practical – VI (Credit 02)	DSC-662-MJE (A): Introduction to Hadoop (Credit 02)					
			DSC-662-MJE (A): Web Application Development (Credit 02)					

Course Structure for M.Sc. Part-I (Data Science) (2023 Pattern)

Sem	Course Type	Course Code	Course Title	Theory/ Practical	No. of Credits
I	Major (Mandatory)	DSC-501-MJM	Probability Distributions	Theory	04
	Major (Mandatory)	DSC -502-MJM	Statistical Inference	Theory	04
	Major (Mandatory)	DSC -503-MJM	Data Science Practical – I	Practical	02
	Major (Mandatory)	DSC -504-MJM	Data Science Practical – II	Practical	02
	Major (Elective)	DSC-511-MJE (A)	Data Base Management System	Theory	04
		DSC -511-MJE (B)	Stochastic Models and Applications	Theory	
	Research Methodology (RM)	DSC -521-RM	Research Methodology	Theory	04
	Total Credits Semester I				**20**
II	Major (Mandatory)	DSC -551-MJM	Design and Analysis of Experiments	Theory	04
	Major (Mandatory)	DSC-552-MJM	Regression Analysis and Predictive Models	Theory	04
	Major (Mandatory)	DSC-553-MJM	Data Science Practical – III	Practical	02
	Major (Mandatory)	DSC-554-MJM	Data Science Practical – IV	Practical	02
	Major (Elective)	DSC -561-MJE (A)	Bayesian Inference	Theory	04
		DSC -561-MJE (B)	Computational Statistics	Theory	
	On Job Training (OJT)/Field Project (FP)	DSC -581-OJT/FP	On Job Training Field Project	Training/Project	04
	Total Credits Semester-II				**20**
	Cumulative Credits Semester I and II				**40**

Course Structure for M.Sc. Part-II (Data Science) (2023 Pattern)

Sem	Course Type	Course Code	Course Title	Theory/ Practical	No. of Credits
III	Major (Mandatory)	DSC-601-MJM	Exploratory Multivariate Data Analysis	Theory	04
	Major (Mandatory)	DSC -602-MJM	Time Series Analysis and Forecasting	Theory	04
	Major (Mandatory)	DSC -603-MJM	Data Science Practical – V	Practical	02
	Major (Mandatory)	DSC -604-MJM	Data Science Practical – VI	Practical	02
	Major (Elective)	DSC-611-MJE(A)	Machine Learning	Theory	02
		DSC -611-MJE(B)	Text Mining and Natural Language Processing	Theory	
		DSC-612-MJE (A)	Machine Learning: Techniques and Applications	Practical	02
		DSC -612-MJE (B)	Practical Based on Text Mining and NLP	Practical	
	Research Project (RP)	DSC -621-RP	Research Project	Project	04
	Total Credits Semester III				**20**
IV	Major (Mandatory)	DSC -651-MJM	Artificial Intelligence	Theory	04
	Major (Mandatory)	DSC-652-MJM	Deep Learning	Theory	04
	Major (Mandatory)	DSC-653-MJM	Data Science Practical – VI	Practical	02
	Major (Elective)	DSC -661-MJE (A)	Supply Chain and Logistics Analytics	Theory	02
		DSC -661-MJE (B)	Discrete Data Analysis	Theory	
		DSC -662-MJE (A)	Introduction to Hadoop	Practical	02
		DSC -662-MJE (B)	Web Application Development	Practical	
	Research Project (RP)	DSC -581-RP	Research Project	Project	06
	Total Credits Semester-IV				**20**
	Cumulative Credits Semester III and IV				**40**

CBCS Syllabus as per NEP 2020 for M.Sc. Part-II Data Science (2023 Pattern)

Name of the Programme	: M.Sc. Data Science
Program Code	: PSDSC
Class	: M.Sc. Part – II
Semester	: IV
Course Type	: Major Mandatory Theory
Course Name	: Artificial Intelligence
Course Code	: DSC-651-MJM
No. of Credits	: 4
No. of Teaching Hours	: 60

Course Objectives:

1. Understand the core concepts and techniques of artificial intelligence, including representation, knowledge base systems, and problem-solving agents.
2. Learn and apply uninformed search strategies to solve real-world problems efficiently.
3. Master knowledge representation using propositional and first-order logic, and implement expert systems with PROLOG.
4. Explore planning methods and basics of artificial neural networks, including neuron models and learning rules.
5. Develop skills in formulating and solving AI problems, considering problem characteristics and rational agent behaviour.

Course Outcomes:

By the end of the course, students will be able to:

CO1. develop a solid understanding of the fundamental concepts and principles of artificial intelligence.

CO2. explore techniques for processing.

CO3. aware of knowledge-based systems.

CO4. use fuzzy logic and neural networks.

CO5. learn a variety of AI algorithms and techniques applicable to different domains, and understand the strengths and limitations of various approaches.

CO6. explore the ethical considerations and societal impacts of AI technologies.

CO7. apply AI techniques to real-world problems in different industries, and understand how AI is used in research and development.

Topics and Learning Points

Unit 1 **(15 L)**

Fundamentals of Artificial Intelligence: Introduction, A.I. Representation, Non-AI & AI Techniques, Representation of Knowledge, Knowledge Base Systems, State Space Search, Production Systems, Problem Characteristics, types of production systems, Intelligent Agents and Environments, concept of rationality, the nature of environments, structure of agents, problem solving agents, problem formulation.

Unit 2 **(15 L)**

Uninformed Search Strategies: Formulation of real-world problems, Breadth First Search, Depth First Search, Depth Limited Search, Iterative Deepening Depth First Search, Bidirectional Search, Comparison of Uninformed search Strategies, Searching with partial information, Sensor-less problems, Contingency problems.

Unit 3 **(15 L)**

Knowledge Representation Knowledge based agents, Wumpus world. Propositional Logic: Representation, Inference, Reasoning Patterns, Resolution, Forward and Backward Chaining. First order Logic: Representation, Inference, Reasoning Patterns, Resolution, Forward and Backward Chaining. Basics of PROLOG: Representation, Structure, Backtracking. Expert System: Case study of Expert System in PROLOG.

Unit 4 **(15 L)**

Introduction to Planning and ANN: Blocks world, STRIPS, Implementation using goal stack, Introduction to Neural networks: - basic, comparison of human brain and machine, biological neuron, general neuron model, activation functions, Perceptron learning rule, applications and advantages of neural networks. Brief introduction to single layer and multiplayer networks.

References:

1. Ivan Bratko : "Prolog Programming For Artificial Intelligence" , 2nd Edition Addison Wesley, 1440.
2. Eugene, Charniak, Drew Mcdermott: "Introduction to Artificial Intelligence.", Addison Wesley
3. Patterson: ―Introduction to AI and Expert Systems‖, PHI
4. Nilsson: ―Principles of Artificial Intelligence‖, Morgan Kaufmann.

5. Carl Townsend, ―Introduction to turbo Prologǁ, Paperback, 1483 6. Jacek M. Zurada, Introduction to artificial neural systems, Jaico Publication.
6. Elaine Rich and Kevin Knight: "Artificial Intelligence." Tata McGraw Hill
7. Stuart Russell & Peter Norvig: "Artificial Intelligence: A Modern Approach", Pearson Education, 2nd Edition.

Programme Outcomes and Course Outcomes Mapping:

Course Outcomes	Programme Outcomes (POs)								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	3		3	1	1		1	3
CO2		3		3	1	1		1	3
CO3		3		3	1	1		1	3
CO4		3		3	1	1		1	3
CO5		3		3	1	1		1	3
CO6		3	3	3	1	1	3	1	3
CO7		3		3	1	1		1	3

Weight: 1 - Partially related 2 - Moderately Related 3 - Strongly related

PO1. Disciplinary Knowledge

CO1. Develop a solid understanding of the fundamental concepts and principles of artificial intelligence. (Weightage: 3 - Strongly Related)

Justification: Developing a solid understanding of AI principles directly contributes to disciplinary knowledge in artificial intelligence.

PO2. Critical Thinking and Problem Solving

All COs (Weightage: 3 - Strongly Related)

Justification: All outcomes involve critical thinking and problem-solving skills in the context of artificial intelligence.

PO3. Social Competence

CO6. Explore the ethical considerations and societal impacts of AI technologies. (Weightage: 3 - Strongly Related)

Justification: Exploring the ethical considerations and societal impacts of AI technologies contributes to social competence.

PO4. Research-related Skills and Scientific Temper

CO7. Apply AI techniques to real-world problems in different industries, and understand how AI is used in research and development. (Weightage: 3 - Strongly Related)

Justification: Applying AI techniques to real-world problems aligns closely with research-related skills and the development of a scientific temper in the context of AI.

PO5. Trans-disciplinary Knowledge

All COs (Weightage: 1 - Partially Related)

Justification: The outcomes are primarily focused on AI techniques and principles, with limited direct connection to trans-disciplinary knowledge.

PO6. Personal and Professional Competence

All COs (Weightage: 1 - Partially Related)

Justification: The outcomes contribute more to technical competence in artificial intelligence, with limited direct connections to personal and professional aspects.

PO7. Effective Citizenship and Ethics

CO6. Explore the ethical considerations and societal impacts of AI technologies. (Weightage: 3 - Strongly Related)

Justification: Exploring ethical considerations and societal impacts aligns with effective citizenship and ethical awareness.

PO8. Environment and Sustainability

All COs (Weightage: 1 - Partially Related)

Justification: The outcomes are more focused on AI techniques and principles, with less direct relevance to environmental or sustainability aspects.

PO9. Self-directed and Life-long Learning

All COs (Weightage: 3 - Strongly Related)

Justification: Continuous exploration of AI techniques and principles aligns well with self-directed and life-long learning in the context of artificial intelligence.

CBCS Syllabus as per NEP 2020 for M.Sc. Part-II Data Science (2023 Pattern)

Name of the Programme	: M.Sc. Data Science
Program Code	: PSDSC
Class	: M.Sc. Part – II
Semester	: IV
Course Type	: Major Mandatory Theory
Course Name	: Deep Learning
Course Code	: DSC-652-MJM
No. of Credits	: 4
No. of Teaching Hours	: 60

Course Objectives:

Students successfully completing this course will be able to:

1. Understand the fundamentals of deep learning, including its history, capabilities, and the basics of neural networks.
2. Gain proficiency in implementing and training neural networks using backpropagation, autoencoders, and batch normalization.
3. Learn to identify and address common issues like overfitting and generalization in deep learning models.
4. Gain advanced knowledge of deep architectures, including recurrent neural networks (RNNs), LSTM, GRU, and Generative Adversarial Networks (GANs).

Course Outcomes:

By the end of the course, students will be able to:

CO1. Evaluate, in the context of a case study, the advantages and disadvantages of deep learning neural network architectures and other approaches.

CO2. Implement deep learning models in Python using the PyTorch library and train them with real-world datasets.

CO3. Design convolution networks for handwriting and object classification from images or video.

CO4. Design recurrent neural networks with attention mechanisms for natural language classification, generation, and translation.

CO5. Explore ethical challenges and considerations in the application of deep learning.

CO6. Evaluate the performance of different deep learning models (e.g., with respect to the bias-variance trade-off, over fitting and under fitting, estimation of test error).

CO7. Perform regularization, training optimization, and hyper parameter selection on deep models.

Topics and Learning Points

Unit 1: **(15 L)**

Deep learning basics: Introduction, History, capabilities, the perceptron, Neural network learning: Back-Propagation, Practical network training o Autoencoders, Batch-normalization, why does it work? Over fitting and generalization.

Unit 2: **(15 L)**

Convolutional neural networks: Introduction to CNNs, Convolution, Correlation, Filtering. CNN architectures, Detection and Segmentation, Visualizing and Understanding, Advanced CNNs for computer vision.

Unit 3: **(20 L)**

Advanced Deep architectures: Recurrent Neural networks (RNNs), Advanced RNN: LSTM, GRU, Generative Adversarial Networks (GANs), Advanced GANs, Advanced topics, Recent papers, Influential papers, Deep reinforcement learning, Deep Learning: Good -> Great, Visual Question Answering, Visual Dialog, Novel deep methods (Deep internal learning, Deep image prior).

Unit 4: **(10 L)**

Tools: Tensor flow, Pytorch, Practical sessions: Computer Vision, Sequence modeling, Natural / Biological signals

References:

1. François Chollet, Deep Learning with Python, Manning Publications Co, ISBN: 9781617294433
2. Rajiv Chopra, Deep Learning - A Practical Approach, Khanna Publications, ISBN: 9789386173416
3. Ian Good fellow, Yoshua Bengio, Aaron Courville, Deep Learning, An MIT Press book.

Programme Outcomes and Course Outcomes Mapping:

Course Outcomes	Programme Outcomes (POs)								
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**
CO1	3	3		3		1		1	3
CO2		3		3		1		1	3
CO3		3		3		1		1	3
CO4		3		3	2	1		1	3
CO5		3	3	3		1	3	1	3
CO6		3		3		1		1	3
CO7		3		3		1		1	3

Weight: 1 - Partially related 2 - Moderately Related 3 - Strongly related

PO1. Disciplinary Knowledge

CO1. Evaluate, in the context of a case study, the advantages and disadvantages of deep learning neural network architectures and other approaches. (Weightage: 3 - Strongly Related)

Justification: Evaluating advantages and disadvantages of deep learning models directly contributes to building disciplinary knowledge in the field.

PO2. Critical Thinking and Problem Solving

All COs (Weightage: 3 - Strongly Related)

Justification: All outcomes involve critical thinking and problem-solving skills, from implementing deep learning models to evaluating their performance and addressing ethical challenges.

PO3. Social Competence

CO5. Explore ethical challenges and considerations in the application of deep learning. (Weightage: 3 - Strongly Related)

Justification: Exploring ethical challenges in the application of deep learning aligns with developing social competence by considering broader societal impacts.

PO4. Research-related Skills and Scientific Temper

All COs (Weightage: 3 - Strongly Related)

Justification: The outcomes align closely with research-related skills and the development of a scientific temper in the context of deep learning research.

PO5. Trans-disciplinary Knowledge

CO4. Design recurrent neural networks with attention mechanisms for natural language classification, generation, and translation. (Weightage: 2 - Moderately Related)

Justification: Designing recurrent neural networks for natural language tasks involves elements of trans-disciplinary knowledge, making this outcome moderately related.

PO6. Personal and Professional Competence

All COs (Weightage: 1 - Partially Related)

Justification: The outcomes contribute more to technical competence in deep learning, with limited direct connections to personal and professional aspects.

PO7. Effective Citizenship and Ethics

CO5. Explore ethical challenges and considerations in the application of deep learning. (Weightage: 3 - Strongly Related)

Justification: Exploring ethical challenges aligns with effective citizenship and ethical considerations in the application of deep learning technologies.

PO8. Environment and Sustainability

All COs (Weightage: 1 - Partially Related)

Justification: The outcomes are more technical and less directly related to environmental or sustainability aspects.

PO9. Self-directed and Life-long Learning

All COs (Weightage: 3 - Strongly Related)

Justification: Continuous exploration of deep learning models aligns with self-directed and life-long learning in this dynamic field.

CBCS Syllabus as per NEP 2020 for M.Sc. Part-II Data Science (2023 Pattern)

Name of the Programme	: M.Sc. Data Science
Program Code	: PSDSC
Class	: M.Sc. Part – II
Semester	: IV
Course Type	: Major Mandatory Practical
Course Name	: Data Science Practical – VI
Course Code	: DSC-653-MJM
No. of Credits	: 2
No. of Teaching Hours	: 60

Course Objectives:

1. To develop proficiency in implementing state space search algorithms (BFS, DFS, IDS) for problem-solving tasks.
2. To apply uninformed search strategies to solve real-world problems, analysing their effectiveness.
3. To acquire knowledge and skills in knowledge representation using propositional and first-order logic.
4. To gain practical experience in logic programming with Prolog, including building expert systems through case studies.
5. To explore and understand various deep learning techniques, including CNNs, RNNs, GANs, and reinforcement learning, and apply them to solve complex tasks in computer vision and sequence modelling.

Course Outcomes:

By the end of the course, students will be able to:

CO1. Demonstrate proficiency in implementing state space search algorithms such as BFS, DFS, and IDS, and apply them to solve a variety of problems.

CO2. Apply uninformed search strategies to real-world problems, analyzing their efficiency and effectiveness in finding solutions.

CO3. Understand and employ knowledge representation techniques in both propositional and first-order logic to model complex domains.

CO4. Develop practical skills in logic programming using PROLOG and apply it to solve logic-based problems.

CO5. Design and develop expert systems using PROLOG, applying them to real-world scenarios for decision-making and problem-solving.

CO6. Explore and implement planning techniques like Blocks World and STRIPS, assessing their suitability for various planning problems.

CO7. Gain hands-on experience with perceptron learning rule and activation functions, understanding their role in neural network training.

Topics and Learning Points

Sr. No.	Title of Experiments
1.	Implementing State Space Search Algorithms: BFS, DFS, and IDS
2.	Solving Real-World Problems with Uninformed Search Strategies
3.	Knowledge Representation in Propositional and First-Order Logic
4.	Practical Implementation of Logic Programming with PROLOG
5.	Building Expert Systems with PROLOG: Case Study Approach
6.	Exploring Planning Techniques: Blocks World and STRIPS
7.	Hands-on Learning: Perceptron Learning Rule and Activation Functions
8.	Introduction to Deep Learning Basics with TensorFlow
9.	Hands-on Training: Convolutional Neural Networks for Image Recognition
10.	Exploring Recurrent Neural Networks with PyTorch
11.	Implementing LSTM and GRU Architectures for Sequence Modelling
12.	Building Generative Adversarial Networks (GANs) for Image Generation
13.	Advanced Computer Vision Techniques using TensorFlow
14.	Deep Reinforcement Learning for Game Playing Applications
15.	Applying Batch Normalization and Autoencoders in Deep Learning Models

Programme Outcomes and Course Outcomes Mapping:

Course Outcomes	Programme Outcomes (POs)								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	3	3	3					3
CO2	2	3							
CO3									
CO4				3	2				
CO5				1			3		
CO6						2			
CO7									

Weight: 1 - Partially related 2 - Moderately Related 3 - Strongly related

PO1. Disciplinary Knowledge

CO1: Demonstrate proficiency in implementing state space search algorithms such as BFS, DFS, and IDS, and apply them to solve a variety of problems.

Justification: Strongly Related (Weightage: 3)

Proficiency in implementing state space search algorithms directly contributes to disciplinary knowledge in artificial intelligence and problem-solving techniques.

CO3: Understand and employ knowledge representation techniques in both propositional and first-order logic to model complex domains.

Justification: Moderately Related (Weightage: 2)

Understanding knowledge representation techniques is moderately related to disciplinary knowledge as it provides a foundational understanding of how complex domains are represented and manipulated in AI systems.

PO2. Critical Thinking and Problem Solving

CO1: Demonstrate proficiency in implementing state space search algorithms such as BFS, DFS, and IDS, and apply them to solve a variety of problems.

Justification: Strongly Related (Weightage: 3)

Proficiency in implementing search algorithms requires critical thinking and problem-solving skills to analyze problem characteristics and select appropriate algorithms.

CO2: Apply uninformed search strategies to real-world problems, analyzing their efficiency and effectiveness in finding solutions.

Justification: Strongly Related (Weightage: 3)

Applying search strategies involves critical thinking to evaluate their efficiency and effectiveness in solving real-world problems, contributing directly to critical thinking and problem-solving skills.

PO3. Social Competence

CO5: Design and develop expert systems using PROLOG, applying them to real-world scenarios for decision-making and problem-solving.

Justification: Partially Related (Weightage: 1)

Designing and developing expert systems involves considerations of ethical implications and societal impacts, contributing partially to social competence.

PO4. Research-related Skills and Scientific Temper

CO1: Demonstrate proficiency in implementing state space search algorithms such as BFS, DFS, and IDS, and apply them to solve a variety of problems.

Justification: Strongly Related (Weightage: 3)

Proficiency in implementing search algorithms fosters research-related skills and scientific temper by experimenting with different algorithms and analyzing their performance.

CO4: Develop practical skills in logic programming using PROLOG and apply it to solve logic-based problems.

Justification: Strongly Related (Weightage: 3)

Developing practical skills in logic programming involves research-related skills and fosters a scientific temper by exploring different problem-solving approaches using PROLOG.

PO5. Trans-disciplinary Knowledge

CO6: Explore and implement planning techniques like Blocks World and STRIPS, assessing their suitability for various planning problems.

Justification: Moderately Related (Weightage: 2)

Exploring planning techniques involves elements of trans-disciplinary knowledge as it requires understanding various domains and their planning requirements.

PO6. Personal and Professional Competence

CO7: Gain hands-on experience with perceptron learning rule and activation functions, understanding their role in neural network training.

Justification: Partially Related (Weightage: 1)

Gaining hands-on experience with neural network training techniques contributes partially to personal and professional competence, focusing more on technical skills development.

PO7. Effective Citizenship and Ethics

CO5: Partially Related (Weightage: 1)

Justification: Designing expert systems involves considerations of ethical implications and effective citizenship in decision-making processes, contributing partially to this outcome.

PO9. Self-directed and Life-long Learning

CO1: Demonstrate proficiency in implementing state space search algorithms such as BFS, DFS, and IDS, and apply them to solve a variety of problems.

Justification: Strongly Related (Weightage: 3)

Proficiency in implementing search algorithms aligns closely with self-directed and life-long learning by fostering continuous exploration and improvement in problem-solving techniques.

CBCS Syllabus as per NEP 2020 for M.Sc. Part-II Data Science (2023 Pattern)

Name of the Programme	: M.Sc. Data Science
Program Code	: PSDSC
Class	: M.Sc. Part – II
Semester	: IV
Course Type	: Major Mandatory Theory
Course Name	: Supply Chain and Logistics Analytics
Course Code	: DSC-661-MJE (A)
No. of Credits	: 2
No. of Teaching Hours	: 30

Course Objectives:

1. To develop an understanding of the various supply chain and logistics processes.
2. To develop knowledge on structures, decision phases, measures and tools of supply
3. chains.
4. To develop understanding on the strategic, tactical and operational decision tools of
5. supply chains.
6. To impart knowledge on logistics management and related advanced tools and
7. techniques.
8. To develop and analyse the role of digital transformation of the supply chains and logistics.

Course Outcomes:

By the end of the course, students will be able to:

CO1. understand the various stages of a supply chain, from sourcing raw materials to delivering finished products to end customers.

CO2. understand the structures, decision phases, measures and tools of supply chains.

CO3. understand the strategic, tactical and operational decision tools of supply chains.

CO4. understand knowledge on logistics management and related advanced tools and techniques.

CO5. understand the role of distribution centres, warehouses, and transportation in the supply chain.

CO6. learn about collaborative approaches to planning, forecasting, and replenishing inventory.

CO7. apply supply chain and logistics concepts to real-world case studies.

Topics and Learning Points

Unit 1 **(10 L)**

Introduction to Supply Chain: The basic Supply Chain model, Generalized Supply Chain Model, Value Chain and Value Chain Analysis, Supply Chain Effectiveness: Strategy, Metrics, Technology, Supplier Performance, Integration and Collaboration, Risk Mitigation, Supply Chain Applications, Information Functionality – The Supply Chain.

Unit 2 **(10 L)**

Supply Chain Design and Planning: Supply Chain Configuration, Extent of Vertical Integration, Outsourcing and Off shoring, Location Decisions, Capacity Planning. Planning Demand & Supply: Planning demand and supply in supply chains – Forecasting techniques for supply chains, Seasonal Forecasting Models, Measure of Forecast errors.

Unit 3 **(10 L)**

Logistics in 21st Century, Definition and Concept of Logistics, Concept of Logistics, Logistics Value Proposition, Service Benefits, Cost Minimization, Logistics Value Generation, The Work of Logistics: Order Processing, Inventory, Transportation, Warehousing, Materials Handling, and Packaging, Facility Network Design, Logistical Operations: Inventory Flow, Physical Distribution, Manufacturing Support, Procurement, Information Flow, Planning and Coordination Flows, Operational Requirements, Logistical Operating Arrangements : Echelon Structured Logistics, Direct Structured Logistics, Flexible Logistics System, Principles of Logistics Information.

References:

1. Neha Tikoo, Logistics and Supply Chain Management
2. Dr. Dawei Lu, Fundamentals of Supply Chain Management
3. David Simchi – Levi & Philip Kaminsk, Designing and Managing the Supply Chain, McGraw-Hill Companies Inc.
4. David Taylor and David Brunt, Manufacturing Operations and Supply Chain Management, Vikas Thomson Learning, 2001.
5. Donald J. Bowersox & David J. Closs, Logistical Management, TMH.
6. Jeremy F. Shapiro, Modeling and Supply Chain,. Thomson Learning, 2001.

Programme Outcomes and Course Outcomes Mapping:

Course Outcomes	Programme Outcomes (POs)								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	2		3					2
CO2	3	2			2				
CO3	3				2				
CO4	3			3	2				
CO5	3		1	1					
CO6	3	2							
CO7	3	2							

PO1. Disciplinary Knowledge (Weightage: 3 - Strongly Related)

CO1. Understand the various stages of a supply chain, from sourcing raw materials to delivering finished products to end customers.

Justification: Understanding the stages of a supply chain is fundamental knowledge in supply chain management, making it strongly related to disciplinary knowledge.

CO2. Understand the structures, decision phases, measures, and tools of supply chains.

Justification: Understanding supply chain structures and decision phases directly contributes to disciplinary knowledge in supply chain management.

CO3. Understand the strategic, tactical, and operational decision tools of supply chains.

Justification: Understanding decision tools in supply chains enhances disciplinary knowledge by providing insights into strategic, tactical, and operational decision-making processes.

CO4. Understand knowledge on logistics management and related advanced tools and techniques.

Justification: Knowledge of logistics management and advanced tools enriches disciplinary knowledge in supply chain management by incorporating advanced techniques and methodologies.

CO5. Understand the role of distribution centers, warehouses, and transportation in the supply chain.

Justification: Understanding the roles of distribution centers, warehouses, and transportation directly contributes to disciplinary knowledge by providing insights into the operational aspects of supply chain management.

CO6. Learn about collaborative approaches to planning, forecasting, and replenishing inventory.

Justification: Learning about collaborative approaches enhances disciplinary knowledge by

providing insights into cooperative planning and inventory management practices in supply chains.

CO7. Apply supply chain and logistics concepts to real-world case studies.

Justification: Applying concepts to real-world case studies reinforces disciplinary knowledge by demonstrating how theoretical concepts are applied in practical supply chain scenarios.

PO2. Critical Thinking and Problem Solving (Weightage: 2 - Moderately Related)

CO1. Understand the various stages of a supply chain, from sourcing raw materials to delivering finished products to end customers.

Justification: Understanding the stages of a supply chain involves critical thinking to identify potential bottlenecks and inefficiencies in the supply chain process.

CO2. Understand the structures, decision phases, measures, and tools of supply chains.

Justification: Understanding supply chain structures and decision phases requires critical thinking to analyze their effectiveness and identify areas for improvement.

CO6. Learn about collaborative approaches to planning, forecasting, and replenishing inventory.

Justification: Learning about collaborative approaches involves critical thinking to assess the benefits and challenges of collaborative planning and forecasting in supply chains.

CO7. Apply supply chain and logistics concepts to real-world case studies.

Justification: Applying concepts to real-world case studies enhances critical thinking by requiring students to analyze complex supply chain problems and propose effective solutions.

PO3. Social Competence (Weightage: 1 - Partially Related)

CO5. Understand the role of distribution centers, warehouses, and transportation in the supply chain.

Justification: Understanding the role of distribution centers, warehouses, and transportation may involve considerations of social impacts and responsibilities, making it partially related to social competence.

PO4. Research-related Skills and Scientific Temper (Weightage: 2 - Moderately Related)

CO2. Understand the structures, decision phases, measures, and tools of supply chains.

Justification: Understanding supply chain structures and decision phases involves research-related skills to analyze and evaluate their effectiveness.

CO3. Understand the strategic, tactical, and operational decision tools of supply chains.

Justification: Understanding decision tools in supply chains requires research-related skills to assess their effectiveness and applicability in different contexts.

CO4. Understand knowledge on logistics management and related advanced tools and techniques.

Justification: Understanding advanced tools and techniques in logistics management involves research-related skills to evaluate their effectiveness and applicability.

PO9. Self-directed and Life-long Learning (Weightage: 2 - Moderately Related)

CO1. Understand the various stages of a supply chain, from sourcing raw materials to delivering finished products to end customers.

Justification: Understanding the stages of a supply chain involves continuous learning to keep up with industry advancements and adapt to changes, making it moderately related to self-directed and life-long learning.

CBCS Syllabus as per NEP 2020 for M.Sc. Part-II Data Science (2023 Pattern)

Name of the Programme	: M.Sc. Data Science
Program Code	: PSDSC
Class	: M.Sc. Part – II
Semester	: IV
Course Type	: Major Elective Theory
Course Name	: Discrete Data Analysis
Course Code	: DSC-661-MJE(B)
No. of Credits	: 2
No. of Teaching Hours	: 60

Course Objectives:

1. To familiarize students to learn about regression analysis and model building for discrete data.
2. To investigate possible diagnostics in various techniques for discrete data.
3. To acquaint students with validation of the generalized linear models using hypothesis testing and analysis of deviance.

Course Outcomes:

By the end of the course, students will be able to:

CO1. develop a solid understanding of the characteristics and challenges of discrete data.

CO2. develop the ability to critically appraise studies and research papers that utilize discrete data analysis methods.

CO3. learn and apply logistic regression for modelling and analysing the relationship between categorical outcomes and predictor variables.

CO4. gain practical experience using statistical software packages (e.g., R, Python) for discrete data analysis.

CO5. effectively communicate the results of discrete data analyses in written reports and oral presentations.

CO6. estimate the parameters and fit different models to discrete data.

CO7. validate the model such as Poisson regression and Logistic Regression using cross validation techniques.

Topics and Learning Points

Unit 1: (10 L)

Log linear model for two and three dimensional contingency tables: Interpretation of parameters, comparison with ANOVA and regression. ML estimation of parameters, likelihood ratio tests for various hypotheses including independence. Marginal and conditional independence, partial association, models with quantitative levels.

Unit 2: (10 L)

Generalized linear models: concept of generalized linear model, Link function, ML estimation, large sample tests about parameters, goodness of fit, analysis of deviance

Unit 3: (10 L)

Poisson regression: ML and Quasi-likelihood estimation of parameters, testing significance of coefficients, goodness of fit, power family of link functions, over dispersion: Types, causes and remedies. Negative Binomial regression: NB-2 model. Non-parametric regression and Interpolating and smoothing splines for simple regression. Use of cross-validation applications to logistic and Poisson regression.

References:

1. Yvonne M. Bishop, Stephen E. Fienberg, Paul W. Holland Discrete (1975): Multivariate Analysis: Theory and Practice
2. Hosmer D.W. and Lemeshow S. (2000): Applied Logistic Regression, 2nd Ed. Wiley, New York.
3. Agesti A. (1990) : Categorical Data Analysis. Wiley, New York.
4. R. Christensen (1997): Log-Linear Models and Logistic Regression. 2nd Ed. Springer, New York.

Programme Outcomes and Course Outcomes Mapping:

Course Outcomes	Programme Outcomes (POs)								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3								
CO2	3	2		1					
CO3	3								
CO4		3							2
CO5		3							
CO6	3								
CO7									

PO1. Disciplinary Knowledge (Weightage: 3 - Strongly Related)

CO1. Develop a solid understanding of the characteristics and challenges of discrete data.

Justification: Understanding the characteristics and challenges of discrete data directly contributes to disciplinary knowledge in statistics and data analysis.

CO2. Develop the ability to critically appraise studies and research papers that utilize discrete data analysis methods.

Justification: Critically appraising studies using discrete data enhances disciplinary knowledge by providing insights into the methodologies and techniques employed in the field.

CO3. Learn and apply logistic regression for modeling and analyzing the relationship between categorical outcomes and predictor variables.

Justification: Learning and applying logistic regression enriches disciplinary knowledge by providing a deeper understanding of statistical modeling techniques for discrete data.

CO6. Estimate the parameters and fit different models to discrete data.

Justification: Estimating parameters and fitting models to discrete data enhances disciplinary knowledge by providing practical experience in statistical modeling techniques.

PO2. Critical Thinking and Problem Solving (Weightage: 3 - Strongly Related)

CO2. Develop the ability to critically appraise studies and research papers that utilize discrete data analysis methods.

Justification: Critically appraising studies involving discrete data analysis requires critical thinking to evaluate the validity and reliability of research findings.

CO4. Gain practical experience using statistical software packages (e.g., R, Python) for discrete data analysis.

Justification: Gaining practical experience in using statistical software for discrete data analysis enhances critical thinking by providing hands-on experience in applying theoretical concepts to real-world data.

CO5. Effectively communicate the results of discrete data analyses in written reports and oral presentations.

Justification: Communicating results of discrete data analyses requires critical thinking to effectively convey complex findings to different audiences.

PO4. Research-related Skills and Scientific Temper (Weightage: 1 - Partially Related)

CO2. Develop the ability to critically appraise studies and research papers that utilize discrete data analysis methods.

Justification: Critically appraising studies involving discrete data analysis enhances research-

related skills by fostering a scientific temper and analytical thinking.

PO9. Self-directed and Life-long Learning (Weightage: 2 - Moderately Related)

CO4. Gain practical experience using statistical software packages (e.g., R, Python) for discrete data analysis.

Justification: Gaining practical experience in using statistical software contributes to self-directed and life-long learning by equipping students with skills that can be continuously developed and applied in their careers.

CBCS Syllabus as per NEP 2020 for M.Sc. Part-II Data Science (2023 Pattern)

Name of the Programme	: M.Sc. Data Science
Program Code	: PSDSC
Class	: M.Sc. Part – II
Semester	: IV
Course Type	: Major Elective Practical
Course Name	: Introduction to Hadoop
Course Code	: DSC-511-MJE(B)
No. of Credits	: 2
No. of Teaching Hours	: 60

Course Objectives:

1. To introduce students to the foundational concepts of Hadoop and its ecosystem.
2. To enable students to set up and configure Hadoop clusters in pseudo-distributed mode.
3. To familiarize students with Hadoop Distributed File System (HDFS) and basic file management commands.
4. To provide hands-on experience in uploading various types of datasets to HDFS.
5. To introduce students to the MapReduce programming paradigm and its implementation within Hadoop.
6. To facilitate understanding of Hadoop environment variables and core configuration files for customization.

Course Outcomes:

By the end of the course, students will be able to:

CO1. Proficiency in setting up and configuring single-node Hadoop clusters to understand fundamental components.

CO2. Mastery of essential HDFS commands for efficient file management within the Hadoop ecosystem.

CO3. Capability to upload diverse datasets to HDFS using command-line tools and web interfaces for seamless data ingestion.

CO4. Understanding of MapReduce programming through execution of the Word Count example and analysis of job logs.

CO5. Competency in configuring Hadoop environment variables and exploring core configuration files for customized deployments.

CO6. Hands-on experience in writing and executing custom MapReduce jobs, enhancing data processing skills within Hadoop.

CO7. Familiarity with various Hadoop ecosystem tools such as HBase, Hive, Pig, and Sqoop, and their respective use cases.

Topics and Learning Points	
Sr. No.	**Title of Experiments**
1.	**Setting up a Single-Node Hadoop Cluster**: Install Hadoop on a single machine in pseudo-distributed mode to understand the basic components.
2.	**Exploring HDFS Commands**: Learn basic Hadoop File System commands such as ls, mkdir, put, get, cat, etc., to interact with files in HDFS.
3.	**Uploading Data to HDFS**: Upload sample datasets (text files, CSV files) to HDFS using Hadoop commands or HDFS web interfaces.
4.	**Running Word Count Example**: Execute the classic Word Count example using MapReduce to understand the basic MapReduce programming paradigm.
5.	**Understanding MapReduce Logs**: Analyze MapReduce job logs to understand how MapReduce jobs are executed and debug potential issues.
6.	**Configuring Hadoop Environment Variables**: Learn to set up environment variables such as HADOOP_HOME, JAVA_HOME, and PATH for Hadoop operations.
7.	**Monitoring Hadoop Services**: Use Hadoop web interfaces (like the Resource Manager UI) to monitor Hadoop services and cluster health.
8.	**Exploring Hadoop Configuration Files**: Understand the purpose and basic configurations in Hadoop's core-site.xml, hdfs-site.xml, and mapred-site.xml files.
9.	Running Simple MapReduce Jobs**: Write and execute custom MapReduce jobs for simple tasks like counting occurrences of specific words in a dataset.**
10.	**Using Hadoop Streaming:** Execute MapReduce jobs using Hadoop Streaming with basic scripts written in languages like Python or Bash.
11.	**Introduction to Hadoop Streaming**: Write a basic mapper and reducer script and execute a MapReduce job using Hadoop Streaming.
12.	**Understanding YARN Resource Allocation**: Learn how YARN allocates resources to different applications and jobs running on the cluster.
13.	**Managing Hadoop Services**: Start, stop, and restart Hadoop services (NameNode, DataNode, ResourceManager, etc.) using command-line tools.
14.	**Understanding Hadoop Ecosystem**: Explore basic components of the Hadoop ecosystem like HBase, Hive, Pig, and Sqoop, and understand their use cases.
15.	**Data Retrieval from HDFS**: Retrieve data stored in HDFS using Hadoop commands or by accessing HDFS via programming interfaces (such as Hadoop API or HDFS client libraries).

References:

1. White T. (2015). Hadoop: The Definitive Guide, O'Reilly Media.
2. Sammer E. (2012). Hadoop Operations, O'Reilly Media.
3. Turkington G. (2014). Learning Hadoop 2, Packt Publishing.
4. Lam C. (2010). Hadoop in Action, Manning Publications.
5. Venner J. (2011). Pro Hadoop, Apress.
6. Perera S., Gunarathne T. (2013). Hadoop MapReduce Cookbook, Packt Publishing.
7. Murthy A.C., Vavilapalli V. (2014). Apache Hadoop YARN: Moving beyond MapReduce and Batch Processing with Apache Hadoop 2, Addison-Wesley Professional.

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Course Outcomes	Programme Outcomes (POs)								
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CO1	3								
CO2	3								
CO3	3								
CO4		3							
CO5									2
CO6		3							
CO7				1					

PO1. Disciplinary Knowledge (Weightage: 3 - Strongly Related)

CO1. Proficiency in setting up and configuring single-node Hadoop clusters to understand fundamental components.

Justification: Developing proficiency in setting up Hadoop clusters directly contributes to disciplinary knowledge in distributed systems and big data technologies.

CO2. Mastery of essential HDFS commands for efficient file management within the Hadoop ecosystem.

Justification: Mastering HDFS commands enhances disciplinary knowledge in data management within distributed systems, which is essential in the field of big data.

CO3. Capability to upload diverse datasets to HDFS using command-line tools and web interfaces for seamless data ingestion.

Justification: The capability to upload datasets to HDFS contributes to disciplinary knowledge by providing practical skills in data ingestion, a crucial aspect of big data systems.

PO2. Critical Thinking and Problem Solving (Weightage: 3 - Strongly Related)

CO4. Understanding of MapReduce programming through execution of the Word Count example and analysis of job logs.

Justification: Understanding MapReduce programming requires critical thinking skills to analyze job logs and identify potential issues or optimizations.

CO6. Hands-on experience in writing and executing custom MapReduce jobs, enhancing data processing skills within Hadoop.

Justification: Writing and executing custom MapReduce jobs involve problem-solving skills to design efficient data processing algorithms tailored to specific requirements.

PO4. Research-related Skills and Scientific Temper (Weightage: 1 - Partially Related)

CO7. Familiarity with various Hadoop ecosystem tools such as HBase, Hive, Pig, and Sqoop, and their respective use cases.

Justification: Familiarity with Hadoop ecosystem tools enhances research-related skills by providing exposure to various data processing and analysis tools commonly used in research and industry.

PO9. Self-directed and Life-long Learning (Weightage: 2 - Moderately Related)

CO5. Competency in configuring Hadoop environment variables and exploring core configuration files for customized deployments.

Justification: Configuring Hadoop environment variables and exploring core configuration files contribute to self-directed and life-long learning by enabling students to adapt to evolving technologies and customize deployments as needed.