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)

well-being.

Anekant Education Society's
Tuljaram Chaturchand College,Baramati
(Autonomous)

Board of Studies (BOS) in Statistics

From 2022-23 to 2024-25

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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 and Statistics for Data Science(Credit 04) DSC-502-MJM: Data Analytics Using R (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: Machine Learning and Artificial intelligence(Credit 04) DSC-552-MJM: Regression Analysis and Predictive Models (Credit 04) DSC-553-MJM: Data Science Practical – III (Credit 02) DSC -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	

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	Machine Learning and Artificial intelligence	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**

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	: Introduction to Generative AI and Large Language Models
Course Code	: DSC-651-MJM
No. of Credits	: 4
No. of Teaching Hours	: 60

Course Objectives:

1. Explain the key concepts, evolution, and applications of Generative AI and Large Language Models (LLMs).
2. Apply probability, embeddings, and matrix operations in language modeling.
3. Examine the structure of deep learning models, loss functions, optimizers, and the Transformer architecture.
4. Explain various tokenization methods, sampling techniques, and controlled text generation approaches.
5. Differentiate between fine-tuning and in-context learning, and apply prompt engineering techniques.
6. Utilize LLMs for statistical queries, report summarization, code assistance, and data analysis.
7. Assess ethical considerations, AI biases, security challenges, and emerging trends in generative AI.

Course Outcomes:

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

CO1. Demonstrate knowledge of generative models, their evolution, and real-world applications.

CO2. Utilize probability, embeddings, and evaluation metrics in language modeling tasks.

CO3. Build and optimize neural network models, understanding backpropagation and optimization strategies.

- Encoder-Decoder Structure
- Variants: Encoder-only (BERT), Decoder-only (GPT), Encoder-Decoder (T5, BART)

Unit 3: **(15 L)**

Tokenization and Text Generation

- What is a Token? Byte Pair Encoding, WordPiece
- Tokenization Process in LLMs
- Sampling Methods: Greedy, Beam Search, Top-k, Top-p
- Controlled Text Generation (Temperature, Repetition Penalty)

Module 6: Prompt Engineering & Fine-Tuning

- Prompt Design: Basic, Chain-of-Thought, Instruction Tuning
- Zero-shot, Few-shot, and Multi-turn Prompts
- Fine-Tuning vs. In-Context Learning
- Parameter-Efficient Fine-Tuning (LoRA, QLoRA, PEFT)

Unit 4: Practical Implementation and Applications **(20 L)**

Applications of LLMs in CS & Statistics

- Natural Language Interfaces for Statistical Queries
- Summarization of Statistical Reports
- LLMs for Code Assistance (Python, R)
- Conversational Agents for Data Analysis
- Introduction to RAG (Retrieval-Augmented Generation),FAISS,Pinecone,LangChain,LlamaIndex

Responsible GenAI & Future Trends

- Ethics in AI: Bias, Fairness, Privacy
- AI Hallucination and Misuse
- Copyright & Licensing Issues with Generated Content
- Open-source Models and Democratization of LLMs
- Future Directions: Multimodal AI, AGI, Agentic Workflows
- Prompt Engineering & AI Agents – Chain-of-thought, AutoGPT, OpenAI Assistants API.
- Multimodal AI – Text-to-image (Stable Diffusion, DALL·E), Text-to-video (Sora, RunwayML).
- LLM Deployment – AWS SageMaker, Vertex AI, On-prem Llama2, Edge AI models.
- Reinforcement Learning & AI Alignment – RLHF, PPO, Self-improving AI.
- AI Security & Ethics – Jailbreak attacks, bias detection, GDPR, AI Act compliance.

Programme Outcomes and Course Outcomes Mapping:

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

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

Justification for CO-PO Mapping

CO1, CO2 → PO1, PO2, PO4 (Comprehensive Knowledge, Practical Expertise, and Problem-Solving)

Students gain a strong foundation in generative models, embeddings, and evaluation metrics for LLMs.

CO3, CO4 → PO3, PO4, PO7 (Technical Skills, Innovation, and Digital Proficiency)

Covers neural networks, optimization, tokenization, and text generation techniques essential for AI innovation

CO5, CO6 → PO2, PO5, PO7 (Practical Implementation and Research Skills)

Focuses on LLM fine-tuning, prompt engineering, and AI-driven applications in real-world domains

CO7 → PO5, PO6, PO8, PO9 (Ethics, Collaboration, and Responsibility in AI Development)

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

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

Topics and Learning Points

Unit1: **(15 L)**

Introduction to Reinforcement Learning, Markov Decision Processes (MDP), Dynamic Programming, Monte Carlo Methods, Temporal Difference Learning (TD), Exploration vs. Exploitation, Deep Reinforcement Learning.

Unit 2: **(15 L)**

Policy Gradient Methods: Understanding Policy-Based Methods, REINFORCE Algorithm, Actor-Critic Methods, Advanced Topics in RL: Advantage Actor-Critic (A2C), Proximal Policy Optimization (PPO) ,Trust Region Policy Optimization (TRPO), Evaluation and Fine-Tuning

Unit 3: **(15 L)**

Introduction to Deep Learning: Basics of Artificial Intelligence, Machine Learning, and Deep Learning, Neural Networks: Biological vs. Artificial Neural Networks, Perceptron Model and Multilayer Perceptrons (MLP), Activation Functions and Loss Functions, Training Neural Networks:Forward and Backward Propagation, Gradient Descent and Optimization Algorithms (SGD, Adam, RMSprop), Hyperparameter Tuning (Learning Rate, Batch Size, Epochs), Regularization Techniques (L1, L2, Dropout),Deep Neural Networks.

Unit 4: **(15L)**

Convolutional Neural Networks (CNNs):Understanding Image Data, Convolutional Layers, Pooling Layers, and Fully Connected Layers, Popular CNN Architectures (LeNet, AlexNet, VGG, ResNet), Transfer Learning and Fine-Tuning

Recurrent Neural Networks (RNNs) and LSTMs: Sequential Data and Time Series Data, Basics of RNNs and Gated Recurrent Units (GRUs), Long Short-Term Memory Networks (LSTMs), Applications of RNNs in Text and Speech Processing

Advanced Topics: Autoencoders and Variational Autoencoders (VAEs), Generative Adversarial Networks (GANs), Attention Mechanism and Transformers, Real-world Applications of Deep Learning

CO7: (Weightage: 2)

Justification: Learners apply deep learning techniques using libraries like TensorFlow and PyTorch, gaining hands-on experience in real-world problem-solving.

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

CO1: (Weightage: 3)

CO2: (Weightage: 3)

CO4: (Weightage: 3)

CO5: (Weightage: 3)

Justification: Problem-solving in tasks such as image classification, NLP, and time series analysis using specialized deep learning models.

PO5. Research, Analytical Reasoning, and Ethical Conduct:

CO4: (Weightage: 3)

CO5: (Weightage: 3)

CO7: (Weightage: 3)

Justification: Learners will interpret deep learning research papers, analyze model performance, and ensure ethical AI practices.

PO6. Communication, Collaboration, and Leadership:

CO4: (Weightage: 3)

CO7: (Weightage: 3)

Justification: Involves collaborative projects, presentations, and discussions to communicate findings effectively.

PO7. Digital Proficiency and Technological Skills:

CO2: (Weightage: 3)

CO6: (Weightage: 3)

CO7: (Weightage: 3)

Justification: Strong hands-on skills in implementing and fine-tuning models using advanced tools and technologies.

PO8. Multicultural Competence, Inclusive Spirit, and Empathy:

Not Directly Addressed

Justification: This course focuses on technical concepts without directly addressing multicultural competence.

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

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.

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-

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

1. Neha Tikoo,Logistics and Supply Chain Management
2. Dr. Dawei Lu,Fundamentals of Supply ChainManagement
3. David Simchi – Levi & Philip Kaminsk, Designing and Managing the SupplyChain, McGraw-Hill Companies Inc.
4. David Taylor and David Brunt, Manufacturing Operations and Supply ChainManagement, 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.

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.

optimization techniques.

CO7. Demonstrate the ability to build and deploy a functional image processing project, solving a real-world problem in healthcare, security, or autonomous systems.

Topics and Learning Points

Unit 1: Fundamentals of Image Processing and Feature Extraction

Introduction to Digital Images: Image representation, pixel values, color spaces (RGB, Grayscale, HSV), Image Transformations: Scaling, rotation, translation, filtering, thresholding, Edge Detection: Sobel, Prewitt, Canny edge detection, Feature Extraction: SIFT, SURF, ORB, HOG descriptors,Image Segmentation Techniques: Thresholding, Region-based segmentation, Watershed algorithm, Hands-on using Python (OpenCV, scikit-image). **(10L)**

Unit 2: Object Detection and Recognition

Object Detection Basics: Contours, bounding boxes, template matching, Feature Matching Techniques: Keypoint matching using SIFT, ORB, and Brute Force Matcher (BFM), Haar Cascades & HOG Classifiers: Face detection using OpenCV, Introduction to Deep Learning-based Detection: YOLO (You Only Look Once), SSD (Single Shot MultiBox Detector), Handwriting Recognition and OCR (Optical Character Recognition) using Tesseract., Hands-on Projects: Object detection in real-world images and videos. **(10L)**

Unit 3: Convolutional Neural Networks (CNNs) and Applications

Introduction to CNNs: Layers in CNN, convolution operation, pooling, activation functions, Popular CNN Architectures: AlexNet, VGGNet, ResNet, EfficientNet, Transfer Learning for Image Classification,Applications of CNNs:Healthcare: Disease detection (COVID-19 X-ray classification, tumor segmentation)., Security: Facial recognition, surveillance systems., Autonomous Systems: Self-driving car vision, object tracking, Hands-on Projects: Implementing CNNs using TensorFlow/Keras & PyTorch. **(10L)**

References:

1. Digital Image Processing" – Rafael C. Gonzalez & Richard E. Woods
2. "Computer Vision: Algorithms and Applications" – Richard Szeliski
3. "Pattern Recognition and Machine Learning" – Christopher M. Bishop
4. "Deep Learning for Computer Vision" – Adrian Rosebrock
5. "Mastering OpenCV with Python" – Alberto Fernández Villán

CO7 → PO10 (Autonomy & Responsibility)

Students independently develop and deploy a fully functional image processing application as a project.

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.	**Using Hadoop Streaming:** Execute MapReduce jobs using Hadoop Streaming with basic scripts written in languages like Python or Bash.
9.	**Introduction to Hadoop Streaming**: Write a basic mapper and reducer script and execute a MapReduce job using Hadoop Streaming.
10.	**Understanding YARN Resource Allocation**: Learn how YARN allocates resources to different applications and jobs running on the cluster.
11.	**Managing Hadoop Services**: Start, stop, and restart Hadoop services (NameNode, DataNode, ResourceManager, etc.) using command-line tools.
12.	**Understanding Hadoop Ecosystem**: Explore basic components of the Hadoop ecosystem like HBase, Hive, Pig, and Sqoop, and understand their use cases.

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.

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.

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	: Web Application Development
Course Code	: DSC-662-MJE (B)

hands-on practical work, project implementation, and a final demonstration.

References:

1. Flask Web Development: Developing Web Applications with Python" – Miguel Grinberg
2. "Django for Beginners" – William S. Vincent
3. "Python Crash Course" – Eric Matthes
4. "Web Development with Django" – Ben Shaw & Saurabh Badhwar
5. "Full Stack Python" – Matt Makai

Programme Outcomes and Course Outcomes Mapping:

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

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

Justification for CO-PO Mapping

CO1, CO2, CO3, CO4, CO5, CO6, CO7 → PO1 & PO2 (Comprehensive Knowledge & Practical Expertise)

The course provides students with a strong understanding of full-stack web development, including front-end, back-end, and database integration.

Students gain hands-on experience in HTML, CSS, JavaScript, React.js, Node.js, and database management, essential for real-world applications.

CO1, CO2, CO3, CO4, CO5, CO6, CO7 → PO3 (Entrepreneurial Mindset & Innovation)

Students will develop a working web application, enhancing their ability to identify problems, design solutions, and innovate.

They learn about market trends and business perspectives through project-based learning.

CO1, CO2, CO3, CO4, CO5, CO6, CO7 → PO4 (Specialized Skills & Problem-Solving)

Students will demonstrate technical proficiency in API handling, database integration, and authentication.

Debugging and performance optimization ensure critical thinking and analytical skills.

CO1, CO2, CO3, CO4, CO5, CO6, CO7 → PO5 (Research & Analytical Reasoning)