LEARNING OUTCOMES BASED CURRICULUM FRAMEWORK (LOCF) FOR POSTGRADUATE PROGRAMMES

(Effective from 2025-26)

M.Sc DATA SCIENCE CURRICULUM FRAMEWORK

DEPARTMENT OF DATA SCIENCE

LOYOLA COLLEGE (AUTONOMOUS)

(Affiliated to University of Madras)

CHENNAI - 600034, INDIA

Preface

Data Science will revolutionize every industry in the near future. India has the opportunity to be the talent provider to the world for data science. Spurring data science-based innovation and establishing data science-ready infrastructure will be critical for preparing India's jobs and skills markets for a data science-based future. In an era where data is the cornerstone of innovation and strategic decision-making, Data Science emerges as a transformative force across industries. Recognizing the exponential rise in demand for data-literate professionals, Loyola College (Autonomous), Chennai, has designed a comprehensive and futuristic curriculum under the M.Sc. Data Science programme. Effective from the academic year 2025–26, this Learning Outcomes Based Curriculum Framework (LOCF) aims to provide students with a robust foundation in theoretical and practical aspects of data analytics.

This curriculum has been meticulously structured to encompass key areas such as Statistical Inference, Machine Learning, Big Data Analytics, Cloud Computing, Deep Learning, Artificial Intelligence, and domain-specific applications through electives like Health and Marketing Analytics. The programme emphasizes experiential learning through intensive lab sessions, case studies, industry guest lectures, and a mandatory internship. A capstone project in the final semester ensures holistic integration of acquired skills and knowledge.

The curriculum is integrating interdisciplinary learning, fostering employability, entrepren eurship, ethical responsibility, and lifelong learning. Students are equipped not only to master data tools and techniques but also to approach complex problems with critical thinking and social consciousness. The Department of Data Science is supported by a team of accomplished faculty members and industry advisors committed to academic excellence and real-world relevance. We believe that this initiative will contribute significantly to nurturing data scientists who are not only technically competent but also ethically grounded and socially aware.

We present this curriculum framework with the hope and confidence that it will empower future data professionals to make informed, impactful contributions in their chosen fields and to the society at large.

Department of Data Science
Loyola College (Autonomous), Chennai

Contents

Vision and Mission of Loyola College

Vision

Towards holistic formation of youth, grounded in excellence, through accompaniment to serve the humanity.

Mission

- To provide inclusive education through an integral and holistic formative pedagogy.
- To promote skills that prepares them for the future.
- To kindle in young minds, the spirit of social and environmental justice with a blend of academic excellence and empathy.
- To stimulate critical and conscientious scholarship leading to meaningful and innovative human Capital.

Core Values

- Cura Personalis
- Pursuit of Excellence
- Moral Rectitude
- Social Equity
- Fostering solidarity
- Global Vision
- Spiritual Quotient

Vision and Mission of the Department

Vision

To be the premier department in shaping young minds to achieve eminence in digital transformation.

Mission

To provide a learning ambience and curiosity to explore new avenues with social responsibilities.

Programme Educational Objectives (PEOs)

PEOs	Statements
PEO1	**Learning Environment and Life Long Learning:** To access academic facilities in an environment of inclusiveness and inquisitiveness for effective and immersed learning throughout life to attain excellence in the chosen field of computational sciences.
PEO2	**Globally Relevant Curriculum and Scientific Temperament:** To think innovatively, analyse scientifically and make decisions appropriately, for handling contemporary global concerns through the knowledge earned in the computational sciences curriculum.
PEO3	**Academic Excellence and Core Competency:** To excel in modern computational techniques and compete in higher studies/career, for addressing contemporary challenging problems with ease.
PEO4	**Skill Development and Entrepreneurship:** To develop analytical, logical and critical problem-solving skills for executing professional work and become experts/entrepreneurs in the field of computational sciences.
PEO5	**Environment and Sustainability:** To identify real world problems concerning environment and other issues; and apply the expertise in the computational sciences, to face the challenges and provide sustainable solutions.
PEO6	**Professionalism and Ethics with Social Responsibility:** To equip themselves with the necessary competency towards professionalism in the computational sciences maintaining ethical standards in addressing the needs of industry and society.

Programme Outcomes (POs)

POs	Statements
PO1	**Disciplinary Knowledge, Information/Digital Literacy & Life-Long Learning:** To acquire scholarly knowledge for life-long learning of the respective discipline of computational sciences and demonstrate digital literacy.
PO2	**Critical, Analytical & Scientific Thinking in Problem-Solving:** To critically explore, scientifically analyze and develop solutions through various computational techniques for real time problems
PO3	**Globally Relevant Curriculum, Industry Requirements and Research Competence:** To acquire research competence and meet industry needs through a globally relevant curriculum
PO4	**Professionalism and Ethics:** To cultivate a promising work culture within ethical frameworks, demonstrating exemplary professionalism.
PO5	**Teamwork and Effective Communications:** To manifest effective communication skills for constructive team work and progress as professionals in key positions in the respective domains.
PO6	**Empowerment with Empathy Towards Sustainable Social and Environmental Consciousness:** To realize social and environmental problems with empathy and contribute the computational expertise to face the challenges and provide sustainable solutions.
PO7	**Skill Development, Employability, Leadership and Entrepreneurship:** To develop expertise and professional skills for employment in the domain of computational sciences and emerge as leaders and entrepreneurs.

Programme Specific Outcomes (PSOs)

PSOs	Statements
PSO1	Ability to identify analyze and design solutions for data analytics problems using fundamental principles of mathematics, Statistics, computing sciences, and relevant domain disciplines
PSO2	Acquire the skills in handling data analytics programming tools towards problem solving and solution analysis for domain specific problems.
PSO3	Understand and commit to professional ethics and cyber regulations, responsibilities, and norms of professional computing practices
PSO4	Understand the role of statistical approaches and apply the same to solve the real-life problems in the fields of data analytics.
PSO5	Ability to apply the advanced concepts of Big Data that pave the way to create a platform to gain analytical skills which impact business decisions and strategies
PSO6	Apply the research-based knowledge to analyse and solve advanced problems in data analytics.
PSO7	To become a skilled Data Scientist in industry, academia, or government and software tools for data storage, analysis and visualization

1 M.Sc. Restructured CBCS Curriculum

Part	Sem I	Sem II	Sem III	Sem IV	Cr.
MC	Fundamentals of Mathematics(5h+4c), Statistics and Probability (4h+4c), Python for Data Science (5h+4c), Python for Data Science Lab (4h+4c), NoSQL Databases (4h+3c), NoSQL Databases Lab (4h+3c), Data Structures and Algorithms (4h+4c)	Statistical Inference (4h+3c), Big Data Analytics (4h+3c), Big Data Analytics Lab (4h+3c), Research Methodology for Data Science (3h+3c), Machine Learning (5h+4c), Machine Learning Lab (4h+4c)	Deep Learning (4h+4c), Deep Learning Lab (4h+3c), Cloud Computing (4h+4c), Cloud Computing Lab (4h+3c), Artificial Intelligence (4h+4c)		
ME		Elective 1A: Marketing Analytics (4h+2c), Elective 1B: Health Analytics (4h+2c)	Elective 2A: Generative AI – Lab (4h+2c), Elective 2B: Edge AI – Lab (4h+2c)		
ID			MEAN Stack (6h+3c)		
SI		Internship (1c)			
PJ				Major Project (16c)	
CD	Cross Disciplinary: Data Analytics/Visualization (3h+1c)				
MO	Self-Study Course - Online (2h+2c)				
LS	Life Skill (2h+1c)				
SK	Soft Skill (2h+1c)				
VA	Value Added Course (2h+1c)				
SL	Service Learning (2h+1c)				
Hr/C	30h/28C	30h/25C	30h/26C	30h/20C	99

Correlation Rubrics

Correlation Level	**Score**
High	3
Moderate	2
Low	1
No Correlation	0

Mapping of PEOs with Vision and Mission

	PEO1	PEO2	PEO3	PEO4	PEO5	PEO6
Vision	3	3	3	3	3	3
Mission	3	3	3	3	3	3

Mapping of POs with PEOs

	PEO1	PEO2	PEO3	PEO4	PEO5	PEO6
PO1	3	3	3	3	3	3
PO2	3	3	3	3	3	3
PO3	3	3	2	2	3	3
PO4	3	3	3	3	2	3
PO5	3	2	3	3	3	3
PO6	3	3	3	3	3	3
PO7	3	3	2	3	3	2

Mapping of PSOs with PEOs

	PEO1	PEO2	PEO3	PEO4	PEO5	PEO6
PSO1	3	3	3	3	3	3
PSO2	3	3	3	3	3	3
PSO3	3	3	3	3	3	3
PSO4	3	3	3	3	3	3
PSO5	3	3	3	3	3	3
PSO6	3	3	3	3	3	2
PSO7	3	3	3	3	3	3

Mapping of PSOs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
PSO1	3	3	3	3	3	3	3
PSO2	3	3	3	3	3	3	3
PSO3	3	3	3	3	3	3	3
PSO4	3	3	3	3	3	3	3
PSO5	3	3	3	3	3	3	3
PSO6	3	3	3	3	3	3	3
PSO7	3	3	3	3	3	3	3

2 Overall Course Structure

Sem	**Sub. Code**	**Course Title**	**T/L**	**Cat.**	**Cr.**	**Hrs.**
I	PDS1MC02	Fundamentals of Mathematics	T	MC	4	5
I	PDS1MC03	Statistics and Probability	T	MC	4	4
I	PDS1MC04	Python for Data Science	T	MC	4	4
I	PDS1MC06	Python for Data Science-Lab	T	MC	4	5
I	PDS1MC08	NoSQL Databases	T	MC	4	5
I	PDS1MC09	NoSQL Databases – Lab	L	MC	4	4
I	PDS1MC10	Data Structures and Algorithms	L	MC	4	4
II	PDS2MC01	Statistical Inference	T	MC	3	4
II	PDS2MC02	Big Data Analytics	T	MC	3	4
II	PDS2MC03	Big Data Analytics - Lab	T	MC	3	4
II	PDS2MC06	Research Methodologies for Data Science	T	MC	3	3
II	PDS2MC07	Machine Learning	L	MC	3	4
II	PDS2MC08	Machine Learning - Lab	L	MC	3	4
II II	PDS2ME01 PDS2ME02	Elective 1A: Marketing Analytics Elective 1B: Health Analytics	T T	ME	2	4
II	PDS3VA01	Cross Disciplinary: Data Analytics through R	T	CD	1	3
II	PHE2LS01	Life Skill - SHE Dept	T	LS	1	2
II	PDS3SI01	Internship	P	SI	2	-
III	PDS3MC02	Deep Learning	T	MC	4	4
III	PDS3MC03	Deep Learning - Lab	L	MC	3	4
III	PDS3MC04	Cloud Computing	T	MC	4	4
III	PDS3MC05	Cloud Computing - Lab	L	MC	3	4
III	PDS3MC06	Artificial Intelligence	T	MC	4	4
III	PDS3ME03 PDS3ME04	Elective 2A: Generative AI – Lab Elective 2B:Edge AI – Lab	T	ME	2	4
III	PDS3ID01	MEAN Stack	L	ID	3	6

Sem	Sub. Code	Course Title	T/L	Category	Cr.	Hrs.
III	PHE3SK01	Soft Skill - SHE Dept	T	SK	1	2
III	PSL3402	Service Learning Dept Course	T	SL	1	2
III	PVC3VA01	Value Added Course	T	VA	1	2
IV	PDS4PJ01	Major Project	PJ	MC	16	-

Courses Offered to Other Departments

Sem	Sub. Code	Course Title	T/L	Cat.	Cr.	Hrs.
II	PDS2CD01	Cross Disciplinary: Data Analytics/Visualization	T	CD	1	3
III	PDS3VA01	Inter Disciplinary: Statistics For Computer Science	T	ID	3	6

3 SEMESTER I

Course Description

3.1 PDS1MC02 - Fundamentals of Mathematics

Course Code	PDS1MC02
Course Title	Fundamentals of Mathematics
Credits	4
Hours/Week	5
Category	Major Core (MC)
Semester	I
Regulation	2022

Course Learning Outcome

CLO1	Demonstrate understanding of basic mathematical concepts in data science, relating to set language, algebra, and calculus.
CLO2	Understand the operations of vector space, matrices, and related transformations.
CLO3	Perform matrix operations and transformations such as PCA, SVD, LU, QR.
CLO4	Use vector calculus for analysis involving multiple variables.
CLO5	Apply distance measures and similarity techniques to identify patterns in data.

Course Objectives

CO1	To perform operations on sets and explore their relations and functions.
CO2	Understand numerical methods for solving algebraic and matrix equations.
CO3	To perform operations on vector space and analyze matrix transformations.
CO4	Analyze functions involving multiple variables using vector calculus.
CO5	To study measures of similarity and differences among vectors.

Prerequisites: Basic knowledge of Mathematical Concepts.

SYLLABUS

UNIT	CONTENT	HRS	COs Mapped
I	**Set Theory and Linear Algebra:** Number system, Sets and their operations, Relations and functions - Relations and their types, Functions and their types. General properties of Vector Space, Vector Subspaces - Algebra of subspaces, Linear Span, Linear sum of two subspaces, Linear Dependence and Independence, Basis, Finite Dimensional Vector Space.	12	CO1–CO5
II	**Matrix Operations:** Linear Transformations, Operators, Rank and Nullity, Matrix of a Linear Transformation, Echelon form, Systems of Linear Equations (Problems only), Eigen values and vectors, Cayley-Hamilton Theorem (Problems).	15	CO1–CO5
III	**Matrix Decomposition:** Symmetric Matrices, Diagonalization, Quadratic Forms, Constrained Optimization, Gram-Schmidt Process, Principal Component analysis, Cholesky decomposition, QR factorization, Least squares method – Singular value decomposition, Moore-Penrose inverse.	18	CO1–CO5
IV	**Multivariable Calculus:** Partial derivatives, Limit, continuity and directional derivatives, maxima and minima of single and multivariable functions using vector calculus.	18	CO1–CO5
V	**Distance Measures:** L_p Distances, Mahalanobis, Cosine, Angular, Jaccard, Edit Distance, Euclidean Distance, Bag of words, k-grams, Normed and Set similarities.	12	CO1–CO5

Text Books

1. David C Lay, *Linear Algebra with Applications*, 4th Edition, Pearson, 2012.
2. Y.N. Singh, *Mathematical Foundations for Computer Science*, New Age Publication, 2005.
3. P.R. Vittal, *Mathematical Foundations*, Margham Publications, 2002.
4. Kenneth Kunen, *The Foundations of Mathematics*, College Publications, 2009.
5. Shahnaz Bhathul, *Mathematical Foundations for Computer Science*, PHI Learning, 2nd Edition, 2010.

Suggested Readings

1. Jeff M. Phillips, *Mathematical Foundations for Data Analysis*, 2018.
2. https://www.cs.utah.edu/ jeffp/M4D/M4D-v0.4.pdf
3. Micheal D. Greenberg, *Foundations of Applied Mathematics*, Dover Publications, 2013.
4. Sheldon Axler, *Linear Algebra Done Right.*

Web Resources

- https://www.udemy.com/course/linear-algebra-for-machine-learning

Course Outcomes (COs) and Cognitive Level Mapping

PDS1MC02	**Fundamentals of Mathematics (MC)**	**Cognitive Levels**
CO1	Understand basic mathematical concepts in set theory and linear algebra.	K1, K2
CO2	Solve linear algebra problems involving matrices and transformations.	K3
CO3	Analyze and perform matrix factorizations and applications in data.	K4
CO4	Evaluate and differentiate functions using multivariable calculus.	K5
CO5	Apply vector-based distance measures and similarity metrics.	K6

Course Description

3.2 PDS1MC03 – Statistics and Probability

Course Code	PDS1MC03
Course Title	Statistics and Probability
Credits	4
Hours/Week	4
Category	Major Core (MC) – Theory
Semester	I
Regulation	2022

Course Learning Outcome

CLO1	Understand concepts of descriptive statistics and definitions.
CLO2	Solve problems in correlation and regression and interpret the results.
CLO3	Apply probability concepts and theorems to real-world problems.
CLO4	Analyze discrete and continuous distribution functions.
CLO5	Identify and apply suitable probability distributions for given scenarios.

Course Objectives

CO1	To understand and perform explanatory data analysis using statistical tools.
CO2	To study the relationship between two variables using correlation and regression analysis.
CO3	To explore foundational concepts in probability theory and their real-world applications.
CO4	To understand and analyze discrete and continuous distribution functions.
CO5	To identify, interpret and apply suitable probability distributions for data-driven problem-solving.

Prerequisites: Basic understanding of Statistics.

SYLLABUS

UNIT	CONTENT	HRS	COs Mapped
I	Sampling Techniques, Data Classification, Tabulation, Frequency and Graphic Representation, Measures of Central Tendency and Variation, Quartiles and Percentiles, Moments, Skewness and Kurtosis.	12	CO1–CO5
II	Scatter Diagram, Karl Pearson's Correlation Coefficient, Rank Correlation, Correlation for Bivariate Frequency Distribution, Regression Coefficients, Fitting of Regression Lines.	12	CO1–CO5
III	Random Experiment, Sample Space, Events, Axiomatic Definition of Probability, Addition and Multiplication Theorems, Bayes' Theorem and its Applications.	12	CO1–CO5
IV	Continuous and Discrete Random Variables, Distribution Function, Probability Mass and Density Functions, Characteristic Functions, Central Limit Theorem.	12	CO1–CO5
V	Probability Distributions, Recurrence Relations, Moment and Cumulant Generating Functions, Rectangular, Binomial, Poisson, Uniform, Normal, and Exponential Distributions.	12	CO1–CO5

Text Books

1. Gupta, S.C., and Kapoor, V.K., *Fundamentals of Mathematical Statistics*, Sultan Chand Sons, New Delhi, 11th Edition, 2002.
2. Hastie, Trevor, et al., *The Elements of Statistical Learning*, Springer, 2009.
3. Ross, S.M., *Introduction to Probability and Statistics*, Academic Foundation, 2011.
4. Papoulis, A., and Pillai, S.U., *Probability, Random Variables and Stochastic Processes*, TMH, 2010.

Web Resources

- https://www.udemy.com/tutorial/learn-probability-concepts-and-counting-techniques
- https://www.udemy.com/tutorial/learn-probability-concepts-and-counting-techniques/concepts

Course Outcomes (COs) and Cognitive Level Mapping

PDS1MC03	Statistics and Probability (MC)	Cognitive Levels
CO1	Understand concepts of descriptive statistics and definitions.	K1, K2
CO2	Solve problems in correlation and regression and interpret results.	K3
CO3	Apply probability theorems and their applications.	K4
CO4	Analyze discrete and continuous distribution functions.	K5
CO5	Identify and apply appropriate probability distributions.	K6

Course Description

3.3 PDS1MC04 – Python for Data Science

Course Code	PDS1MC04
Course Title	Python for Data Science
Credits	4
Hours/Week	5
Category	Major Core (MC) – Theory
Semester	I
Regulation	2022

Course Learning Outcome

CLO1	Understand and apply the Python Programming concepts.
CLO2	Apply the functions available in Numpy and Pandas packages.
CLO3	Illustrate Data Wrangling operations in different contexts.
CLO4	Assess the usage of Data Aggregation and Grouping operations.
CLO5	Construct visuals for various real-world problems.

Course Objectives

CO1	To develop Python programming skills with data science perspective.
CO2	To perform Data Wrangling operations of different types.
CO3	To effectively perform Data Aggregation, Grouping operations and Data Visualization.

Prerequisites: Basic programming knowledge.

SYLLABUS

UNIT	CONTENT	HRS	COs Mapped
I	Installing and using Jupyter Notebook – Creating and executing Python Programs – Statements – Expressions – Variables – Operators – Data Types – Type Conversions – Control Flow Statements – Exception Handling.	15	CO1–CO5
II	Functions – Data Structures: Lists, Dictionaries, Tuples, Sets – File handling – Regular Expressions – Object-Oriented Programming.	15	CO1–CO5
III	Functional Programming: Lambda, Iterators, Generators, List Comprehensions – NumPy Arrays – Pandas Series – Pandas DataFrames.	15	CO1–CO5
IV	Data Wrangling with Pandas – Querying DataFrames – Merging DataFrames – Applying Functions to DataFrames – Aggregations with Pandas and NumPy.	15	CO1–CO5
V	Matplotlib package – Pandas.Plotting package: Scatter matrices, Lag Plots, Autocorrelation Plots, Bootstrap Plots – Seaborn Package: Stripplot, Swarmplot, Heatmap, Pairplot, Regression Plot – Formatting – Customizing Visualizations.	15	CO1–CO5

Text Books

1. Gowrishanker and Veena, *Introduction to Python Programming*, CRC Press, 2019.
2. Stefanie Molin, *Data Analysis with Pandas*, Packt, 2019.
3. Joel Grus, *Data Science from Scratch*, O'Reilly, 2015.
4. Wes McKinney, *Python for Data Analysis*, O'Reilly Media, 2012.
5. Jake VanderPlas, *Python Data Science Handbook: Essential Tools for Working with Data*, 2012.

Course Outcomes (COs) and Cognitive Level Mapping

PDS1MC04	Python for Data Science (MC)	Cognitive Levels
CO1	To understand and apply the Python Programming concepts.	K1, K2
CO2	To apply the functions available in Numpy and Pandas packages.	K3
CO3	To illustrate Data Wrangling operations in different contexts.	K4
CO4	To assess the usage of Data Aggregation and Grouping operations.	K5
CO5	To construct Visuals for various real-world problems.	K6

Course Description

3.4 PDS1MC06 – Python for Data Science - Lab

Course Code	PDS1MC06
Course Title	Python for Data Science Lab
Credits	4
Hours/Week	4
Category	Major Core (MC) – Lab
Semester	I
Regulation	2022

Course Learning Outcome

CLO1	Make use of data structures in Python to represent different types of data.
CLO2	Apply OOP concepts in Python to solve a variety of problems.
CLO3	Develop solutions using the functions in Numpy and Pandas packages.
CLO4	Perform data wrangling, data aggregation and grouping operations.
CLO5	Build effective data visualizations for different contexts.

Course Objectives

CO1	To understand and apply data structures in Python for efficient data representation.
CO2	To apply Object-Oriented Programming (OOP) concepts to develop reusable and modular Python programs.
CO3	To develop data processing solutions using NumPy and Pandas libraries.
CO4	To perform data wrangling, data aggregation, and grouping operations on real-world datasets.
CO5	To build clear and insightful data visualizations using Python libraries like Matplotlib and Seaborn.

Prerequisites: Basic programming knowledge.

SYLLABUS

UNIT	CONTENT	HRS	COs Mapped
I	1. Editing and executing Programs involving Flow Controls. 2. Editing and executing Programs involving Functions. 3. Program in String Manipulations.	12	CO1–CO5
II	4. Creating and manipulating a Tuple. 5. Creating and manipulating a List. 6. Creating and manipulating a Dictionary.	12	CO1–CO5
III	7. Object Creation and Usage. 8. Program involving Inheritance. 9. Program involving Overloading.	12	CO1–CO5
IV	10. Reading and Writing with Text Files and Binary Files. 11. Combining and Merging Data Sets.	12	CO1–CO5
V	12. Program involving Regular Expressions. 13. Data Aggregation and GroupWise Operations.	12	CO1–CO5

Text Books

1. Gowrishanker and Veena, *Introduction to Python Programming*, CRC Press, 2019.
2. Stefanie Molin, *Data Analysis with Pandas*, Packt, 2019.
3. Joel Grus, *Data Science from Scratch*, O'Reilly, 2015.
4. Wes McKinney, *Python for Data Analysis*, O'Reilly Media, 2012.
5. Jake VanderPlas, *Python Data Science Handbook: Essential Tools for Working with Data*, 2012.

Course Outcomes (COs) and Cognitive Level Mapping

PDS1MC06	Python for Data Science Lab (MC)	Cognitive Levels
CO1	Make use of data structures in Python to represent different types of data.	K1, K2
CO2	Apply OOP concepts in Python to solve a variety of problems.	K3
CO3	Develop solutions using the functions in Numpy and Pandas packages.	K3
CO4	Perform data wrangling, data aggregation and grouping operations.	K4
CO5	Build effective data visualizations for different contexts.	K5

Course Description

3.5 PDS1MC08- NoSQL Databases

Course Code	PDS1MC08
Course Title	NoSQL Databases
Credits	3
Hours/Week	4
Category	Major Core (MC) – Theory
Semester	I
Regulation	2022

Course Learning Outcome

CLO1	Understand the basics of relational and NoSQL databases, including SQL and MongoDB.
CLO2	Explore and differentiate NoSQL types: Key-Value, Document, Columnar, and Graph databases.
CLO3	Analyze data modeling techniques and suitable use cases for various NoSQL types.
CLO4	Demonstrate competency in managing and querying NoSQL systems like MongoDB, Cassandra, HBase, and Neo4j.
CLO5	Design solutions using appropriate NoSQL models for real-world data challenges.

Course Objectives

CO1	Gain knowledge of SQL and MongoDB query language.
CO2	Comprehend the principles and features of NoSQL databases.
CO3	Differentiate key-value, document, and column-oriented databases.
CO4	Explore graph-based data modeling and its applications.
CO5	Understand data modeling techniques for various NoSQL scenarios.

Prerequisites: Basic knowledge of Big Data.

SYLLABUS

UNIT	CONTENT	HRS	COs Mapped
I	**Relational Database Fundamentals:** Table creation, insertion, deletion, update, constraints, joins, subqueries, functions, and normalization.	12	CO1
II	**Introduction to NoSQL:** History, architecture, key differences from RDBMS, types of NoSQL (Key-Value, Document, Column, Graph), comparison with RDBMS, replication and sharding models.	12	CO2–CO5
III	**Key-Value and Document Databases:** MongoDB operations, consistency, scaling, transactions, analytics use cases like content management, e-commerce, real-time analytics.	12	CO2–CO5
IV	**Column-Oriented Databases:** Apache HBase, Cassandra architecture, column-family data stores, scaling and availability, use cases such as counters and CMS.	12	CO2–CO5
V	**Graph Databases and Modeling:** Graph vs relational modeling, property graph model, PageRank, Markov chains, random walk, iterative processing, querying graphs.	12	CO2–CO5

Text Book

1. P. Sadalage and Martin Fowler, *NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence*, Wiley Publications, 1st Edition, 2022.

Suggested Readings

1. Christopher D. Manning, Prabhakar Raghavan, Hinrich Schütze, *An Introduction to Information Retrieval*, Cambridge University Press.

2. Daniel Abadi, Peter Boncz, Stavros Harizopoulos, *The Design and Implementation of Modern Column-Oriented Database Systems*, Now Publishers.

3. Guy Harrison, *Next Generation Databases: NoSQL and Big Data*, Apress.

Web Resources

- https://www.oracle.com/in/database/nosql/technologies/nosql/
- https://www.coursera.org/lecture/nosql-databases/introduction-to-nosql-VdRNp
- https://www.geeksforgeeks.org/introduction-to-nosql/
- https://www.javatpoint.com/nosql-database

Course Outcomes (COs) and Cognitive Level Mapping

PDS1MC08	**NoSQL Databases (MC)**	**Cognitive Levels**
CO1	To remember and understand SQL concepts and relational operations.	K1, K2, K3
CO2	To apply and analyze key-value and column-based NoSQL systems.	K1, K2, K3
CO3	To illustrate operations and capabilities of NoSQL databases.	K3, K4
CO4	To evaluate technologies like MongoDB, HBase, Cassandra, Neo4j.	K5
CO5	To construct NoSQL solutions for real-world data-intensive applications.	K6

Course Description

3.6 PDS1MC09-NoSQL Databases – Lab

Course Code	PDS1MC09
Course Title	NoSQL Databases – Lab
Credits	3
Hours/Week	4
Category	Major Core (MC) – Lab
Semester	I
Regulation	2022

Course Learning Outcome

CLO1	Demonstrate the ability to execute NoSQL queries for creating, reading, updating, and deleting documents in MongoDB.
CLO2	Understand different types of NoSQL databases such as key-value, column-family, and graph databases.
CLO3	Implement and use aggregate functions and expressions in MongoDB.
CLO4	Manage replication, backup, and restoration in NoSQL systems.
CLO5	Connect NoSQL databases with Python and perform CRUD operations.

Course Objectives

CO1	Demonstrate competency in designing NoSQL database management systems.
CO2	Explain how NoSQL databases differ from relational databases from a theoretical perspective.
CO3	Select appropriate NoSQL databases for specific real-world use cases.

Prerequisites: Basic knowledge in SQL and Big Data.

SYLLABUS

UNIT	CONTENT	HRS	COs Mapped
I	**MongoDB Basics:** Create/Drop databases, Create/Drop collections, Insert, Query, Update, Delete documents.	12	CO1–CO5
II	**NoSQL Data Models:** Key-value databases, Column-family stores using Cassandra, Graph databases using Neo4j.	12	CO1–CO5
III	**MongoDB Aggregation:** Aggregate functions, push and addToSet expressions, first and last expressions.	12	CO1–CO5
IV	**Database Management:** Creating replicas, performing backups of MongoDB databases.	12	CO1–CO5
V	**Python Integration:** Restore databases, connect MongoDB with Python, perform CRUD operations via Python scripts.	12	CO1–CO5

Text Books

1. Shakuntala Gupta Edward, Navin Sabharwal, *Practical MongoDB*, Apress.

2. Pramod Sadalage, Martin Fowler, *NoSQL Distilled*, Pearson.

3. Wiley Brand, *NoSQL for Dummies*, Wiley.

Suggested Readings

1. Christopher D. Manning, Prabhakar Raghavan, Hinrich Schütze, *An Introduction to Information Retrieval*, Cambridge University Press.

2. Daniel Abadi, Peter Boncz, Stavros Harizopoulos, *Design and Implementation of Modern Column-Oriented DB Systems*, Now Publishers.

3. Guy Harrison, *Next Generation Databases: NoSQL and Big Data*, Apress.

Web Resources

- https://www.oracle.com/in/database/nosql/technologies/nosql/
- https://www.coursera.org/lecture/nosql-databases/introduction-to-nosql-VdRNp
- https://www.geeksforgeeks.org/introduction-to-nosql/
- https://www.javatpoint.com/nosql-database

Course Outcomes (COs) and Cognitive Level Mapping

PDS1MC09	**NoSQL Databases – Lab (MC)**	**Cognitive Levels**
CO1	To remember and understand NoSQL basic query operations.	K1, K2
CO2	To apply data insertion, querying, and optimization in NoSQL column databases.	K3
CO3	To illustrate NoSQL operations within Big Data environments.	K4
CO4	To evaluate NoSQL systems like Cassandra, HBase, MongoDB, and Neo4j using datasets.	K5
CO5	To construct NoSQL-based solutions to address real-world application challenges.	K6

Course Description

3.7 PDS1MC10-Data Structures and Algorithms

Course Code	PDS1MC10
Course Title	DATA STRUCTURES AND ALGORITHMS
Credits	4

Hours/Week	4
Category	MC
Semester	I
Regulation	2025

Course Learning Outcome:

CLO1	To understand the design of algorithms and analysis techniques.
CLO2	To enable the students to analyse the time and space complexity of algorithms.
CLO3	To have a good understanding on different data structures.
CLO4	To understand the kinds of problems that use the data structures and the algorithms for solving them.
CLO5	Identify appropriate data structures for real time applications.

Course Objective:

CO1	Understand the fundamental concepts of algorithm design, analysis, and complexity including asymptotic notations and problem-solving techniques.
CO2	Gain knowledge of Abstract Data Types such as List, Stack, and Queue and their implementations.
CO3	Analyze and apply algorithmic design strategies such as Greedy, Divide and Conquer, Dynamic Programming, Backtracking, and Branch and Bound.
CO4	Explore and implement data structures like Trees, Hashing, Heaps, and their applications.
CO5	Understand sorting and graph algorithms and examine the concept of NP-Completeness and complexity classes.

Prerequisites: Basic understanding of data handling

SYLLABUS

UNIT	CONTENT	HRS	COs	COGNITIVE LEVEL
I	**1.1 Basic Concepts:** Steps in algorithm development, Analysis and complexity, Asymptotic notations, Problem-solving techniques and examples. **1.2 ADT:** List ADT, Stack ADT, Queue ADT.	8	CO1-CO5	K1-K6
II	**2.1 Algorithm Design Models:** Greedy Method, Divide and Conquer, Dynamic Programming, Backtracking, Branch and Bound. **2.2 Trees:** Preliminaries, Binary Tree, Search Tree ADT, Binary Search Trees, AVL Trees, Tree Traversals, B-Trees.	14	CO1-CO5	K1-K6
III	**3.1 Hashing:** Hash functions, Separate chaining, Open addressing, Rehashing, Extendible Hashing. **Priority Queues:** Binary Heap, Applications.	14	CO1-CO5	K1-K6
IV	**Sorting:** Insertion Sort, Shell Sort, Heap Sort, Merge Sort, Quick Sort, External Sorting.	12	CO1-CO5	K1-K6
V	**5.1 Graphs:** Definitions, Topological Sort, Shortest Path Algorithm, Minimum Spanning Tree, DFS Applications. **5.2 NP-Completeness:** Complexity classes (P, NP), NP-Completeness, NP-Hard problems.	12	CO1-CO5	K1-K6

TEXT BOOKS:

1. Jojo Moolayil, "Smarter Decisions : The Intersection of IoT and Data Science", PACKT, 2016.
2. Cathy O'Neil and Rachel Schutt, "Doing Data Science", O'Reilly, 2015.
3. David Dietrich, Barry Heller, Beibei Yang, "Data Science and Big data Analytics", EMC 2013
4. Raj, Pethuru, "Handbook of Research on Cloud Infrastructures for Big Data Analytics", IGI Global.

SUGGESTED READINGS:

1. Jojo Moolayil, "Smarter Decisions: The Intersection of IoT and Data Science", PACKT, 2016.

2. Joel Grus, "Data Science from Scratch" O'REILLY, 2018.

3. Rafael A. Irizarry, "Introduction to Data Science", Chapman & Hall, 2022

4. Gupta. S.C. & Kapoor,V.K., Fundamentals of Mathematical Statistics, Sultan Chand & Sons Pvt. Ltd. New Delhi,2002.

Website:

- https://www.udemy.com/course/introduction-to-data-science/
- https://www.youtube.com/watch?v=9IRv01HDU0s/Ridge and Lasso
- https://www.coursera.org/learn/regression-models
- https://www.simplilearn.com/tutorials/machine-learning-tutorial/overfitting-and-underfitting

Course Outcomes (COs) and Cognitive Level Mapping

PDS1MC10 (MC)	**DATA STRUCTURES AND ALGORITHMS**	**Cognitive Levels**
CO1	Understand the fundamental concepts of algorithm design, analysis, and complexity including asymptotic notations and problem-solving techniques.	K1, K2
CO2	Gain knowledge of Abstract Data Types such as List, Stack, and Queue and their implementations.	K3
CO3	Analyze and apply algorithmic design strategies such as Greedy, Divide and Conquer, Dynamic Programming, Backtracking, and Branch and Bound.	K4
CO4	Explore and implement data structures like Trees, Hashing, Heaps, and their applications.	K5
CO5	Understand sorting and graph algorithms and examine the concept of NP-Completeness and complexity classes.	K6

4 SEMESTER II

Course Description

4.1 PDS2MC01 - Statistical Inference

Course Code	PDS2MC01
Course Title	Statistical Inference
Credits	3
Hours/Week	4
Category	Major Core (MC) – Theory
Semester	II
Regulation	2022

Course Learning Outcome

CLO1	Understand and apply basic concepts of statistical inference.
CLO2	Interpret and apply important results such as NP Lemma and Likelihood Ratio (LR) Test.
CLO3	Derive conclusions from large sample tests.
CLO4	Apply concepts related to small sample tests using various distributions.
CLO5	Identify problem contexts and apply appropriate non-parametric tests.

Course Objectives

CO1	To study the basic concepts of Statistical Inference.
CO2	To apply important results such as NP Lemma and LR test.
CO3	To study Large Sample Tests and Small Sample Tests.
CO4	To identify problematic situations and apply Non-parametric Tests.

Prerequisites: Basic understanding of Statistics.

SYLLABUS

UNIT	CONTENT	HRS	COs Mapped
I	Statistical Hypothesis – Simple and Composite hypothesis, Null and Alternative hypothesis – Errors, level of significance, size and power, most powerful test – Neyman-Pearson Lemma with proof.	14	CO1–CO5
II	Examples using NP Lemma – Uniformly most powerful and unbiased tests – Likelihood Ratio Test and properties – Application of LR test for single mean.	15	CO1–CO5
III	Test of significance for means, variances, proportions, and correlation coefficients using Normal distribution.	15	CO1–CO5
IV	Test of significance using t, Chi-square, and F-distributions – Chi-square tests for independence and goodness of fit – ANOVA: One-way, Two-way – CRD, RBD, LSD.	15	CO1–CO5
V	Non-parametric tests: Kolmogorov-Smirnov, Sign test, Wald-Wolfowitz run test, Median test, Wilcoxon test, Wilcoxon–Mann–Whitney U test.	15	CO1–CO5

Text Books

1. Gupta, S.C. and Kapoor, V.K., *Fundamentals of Mathematical Statistics*, Sultan Chand Sons, 11th Ed., 2002.
2. Rohatgi, V.K., *Statistical Inference*, John Wiley Sons, 1984.
3. Hogg, R.V., Craig, A.T. and Tannis, *Introduction to Mathematical Statistics*, Prentice Hall, 1995.
4. Dudewicz, E.J. and Mishra, S.N., *Modern Mathematical Statistics*, John Wiley Sons, 1988.

Web Resources

- https://www.udemy.com/tutorial/python-for-statistical-analysis/hypotesis-introduction/
- https://www.coursera.org/lecture/inferential-statistics-intro/the-chi-square-independence-test-LEIm3
- https://www.youtube.com/watch?v=RgKy7URFx1c

Course Outcomes (COs) and Cognitive Level Mapping

PDS2MC01	Statistical Inference (MC)	Cognitive Levels
CO1	Definitions and concepts of statistical inference.	K1, K2
CO2	Interpretations and applications of NP Lemma and LR test.	K3
CO3	Concepts of large sample tests.	K4
CO4	Concepts of small sample tests.	K5
CO5	Identification and application of suitable non-parametric tests.	K6

Course Description

4.2 PDS2MC02 - Big Data Analytics through Spark

Course Code	PDS2MC02
Course Title	Big Data Analytics through Spark
Credits	3
Hours/Week	4
Category	Major Core (MC) – Theory
Semester	II
Regulation	2022

Course Learning Outcome

CLO1	Understand Spark programming and data operations.
CLO2	Apply algorithmic logic to Spark RDD and SQL.
CLO3	Analyze and perform operations using Spark SQL and temporary tables.
CLO4	Assess and process streaming data using Spark Streaming.
CLO5	Construct machine learning solutions using Spark MLlib.

Course Objectives

CO1	To develop dynamic RDD Spark programming using different datasets.
CO2	To perform Big Data analytics using Spark.
CO3	To build machine learning models for Big Data applications.

Prerequisites: Basic programming knowledge.

SYLLABUS

UNIT	CONTENT	HRS	COs Mapped
I	Introduction to Big Data and Hadoop – Importance, characteristics, applications – HDFS – Map Reduce – Hadoop Ecosystem.	12	CO1–CO5
II	Apache Spark Ecosystem – RDDs – Spark Architecture – Transformations, Actions – Variables, Broadcast, Accumulators – Partitioning, Persistence.	12	CO1–CO5
III	Spark SQL – Spark Session – DataFrames – Schema, Operations (Filter, Join, GroupBy, Agg) – Temporary Tables.	12	CO1–CO5
IV	Spark Streaming – Real-time analytics use cases – Flume, Kafka, Kinesis – Streaming Context – DStreams operations.	12	CO1–CO5
V	Machine Learning with Spark – Linear Regression, Decision Tree, PCA, Random Forest, TF-IDF, Naive Bayes, K-Means, Recommender Systems.	12	CO1–CO5

Text Books

1. Michael Berthold and David J. Hand, *Intelligent Data Analysis*, Springer, 2007.
2. Tom White, *Hadoop: The Definitive Guide*, O'Reilly Media, 3rd Edition, 2011.
3. Tomasz Drabos, *Learning PySpark*, PACKT, 2017.

Suggested Readings

1. Padma Priya Chitturi, *Apache Spark for Data Science*, PACKT, 2017.
2. Holden Karau, *Learning Spark*, PACKT, 2016.
3. Sandy Ryza, *Advanced Analytics with Spark*, O'Reilly, 2016.
4. Romeo Kienzler, *Mastering Apache Spark*, PACKT, 2017.

Web Resources

- https://spark.apache.org/
- https://databricks.com/

Course Outcomes (COs) and Cognitive Level Mapping

PDS2MC02	Big Data Analytics through Spark (MC)	Cognitive Levels
CO1	To remember and understand Spark programming concepts.	K1, K2
CO2	To apply algorithm constructs to implement RDD concepts.	K3
CO3	To illustrate Spark SQL and Temp Table operations.	K4
CO4	To assess Spark Streaming operations using various methods.	K5
CO5	To construct solutions using Spark MLlib for real-time analytics.	K6

Course Description

4.3 PDS2MC03 – Big Data Analytics through Spark - Lab

Course Code	PDS2MC03
Course Title	Big Data Analytics through Spark - Lab
Credits	3
Hours/Week	4
Category	Major Core (MC) – Lab
Semester	II
Regulation	2022

Course Learning Outcome

CLO1	Understand and apply the concept of Resilient Distributed Datasets (RDDs) in Spark.
CLO2	Perform Spark transformations and actions using real-world datasets.
CLO3	Implement Spark SQL queries and temporary table operations.
CLO4	Stream and analyze real-time data using Spark Streaming.
CLO5	Apply Machine Learning models such as Regression, Classification, and Clustering in Spark.

Course Objectives

CO1	To apply RDD concepts to solve real-world problems.
CO2	To develop dynamic Spark programs using different datasets.
CO3	To perform analysis on big data using various Spark-based methods.
CO4	To build machine learning models using Spark's MLlib library.
CO5	To integrate streaming data sources and analyze live data feeds.

Prerequisites: Basic programming knowledge.

SYLLABUS

UNIT	CONTENT	HRS	COs Mapped
I	1. Program involving Resilient Distributed Datasets 2. Program involving Transformations and Actions 3 Program involving Key-Value Resilient Distributed Datasets	12	CO1–CO5
II	4. Program involving Local Variables, Broadcast Variables and Accumulators 5. Program involving Filter, Join, GroupBy, Agg operations 6. Viewing and Querying Temporary Tables	12	CO1–CO5
III	7. Transferring, Summarizing and Analysing Twitter data 8. Program involving Flume, Kafka and Kinesis 9. Program involving DStreams and Dstream RDDs	12	CO1–CO5
IV	10. Linear Regression 11. Decision Tree Classification 12. Principal Component Analysis	12	CO1–CO5
V	13.Random Forest Classification 14.Text Pre-processing with TF-IDF 15. Naïve Bayes Classification K-Means Clustering	12	CO1–CO5

Text Books

1. Michael Berthold, David J. Hand, *Intelligent Data Analysis*, Springer, 2007.
2. Tom White, *Hadoop: The Definitive Guide*, Third Edition, O'Reilly Media, 2011.
3. Tomasz Drabas, *Learning PySpark*, PACKT, 2017.

Suggested Readings

1. Padma Priya Chitturi, *Apache Spark for Data Science*, PACKT, 2017.

2. Holden Karau, *Learning Spark*, PACKT, 2016.

3. Sandy Ryza, *Advanced Analytics with Spark*, O'Reilly, 2016.

4. Romeo Kienzler, *Mastering Apache Spark*, PACKT, 2017.

Web Resources

- https://spark.apache.org/
- https://databricks.com/

Course Outcomes (COs) and Cognitive Level Mapping

PDS2MC03	**Big Data Analytics through Spark - Lab (MC)**	**Cognitive Levels**
CO1	To remember and understand the RDD operation concepts.	K1, K2
CO2	To apply RDD operations to big data problems.	K3
CO3	To implement Spark SQL operations using temporary tables.	K3, K4
CO4	To analyze and visualize streamed data from various sources.	K4, K5
CO5	To build and evaluate machine learning models using Spark.	K5, K6

Course Description

4.4 PDS2MC06-Research Methodologies for Data Science

Course Code	PDS2MC06
Course Title	Research Methodologies for Data Science
Credits	3
Hours/Week	4
Category	Major Core (MC) – Theory
Semester	II
Regulation	2022

Course Learning Outcome

CLO1	Understand the fundamental principles of research methods and methodologies in data science.
CLO2	Formulate research problems effectively and conduct thorough literature reviews.
CLO3	Acquire practical web scraping skills using Python libraries including BeautifulSoup and Selenium.
CLO4	Apply storytelling techniques to convey data insights clearly and ethically.
CLO5	Utilize Power BI for data analysis, dashboard design, and storytelling using DAX functions.

Course Objectives

CO1	Understand the fundamental concepts of research methods and methodology.
CO2	Formulate and define research problems and identify research gaps through literature reviews.
CO3	Acquire skills in web scraping using Python (e.g., BeautifulSoup, Selenium).
CO4	Apply data storytelling techniques to communicate insights from analysis.
CO5	Utilize Power BI for data visualization and dashboard creation using DAX.

Prerequisites: Basic knowledge of Python, statistics, and data visualization.

SYLLABUS

UNIT	CONTENT	HRS	COs Mapped
I	**Research Fundamentals:** Motivation and objectives, research methods vs. methodology, types of research (descriptive vs. analytical, applied vs. fundamental, quantitative vs. qualitative, conceptual vs. empirical), basic and applied research processes, criteria for good research.	12	CO1
II	**Problem Formulation and Report Writing:** Defining the research problem, selecting and reviewing literature, use of databases, identifying research gaps, writing reviews. **Report Writing:** Structure, style, and best practices.	12	CO2
III	**Web Scraping:** Overview, ethics, tools (BeautifulSoup, Scrapy, Requests), extracting and parsing data, navigating parse trees, scraping dynamic content using Selenium, interaction with JavaScript-driven sites.	12	CO3
IV	**Data Storytelling:** Audience understanding, narrative crafting, visual storytelling, tools, delivery, ethical considerations. **Case Studies:** Critiquing real-world data stories.	12	CO4
V	**Data Visualization using Power BI:** Data preparation, basic and advanced visualizations, dashboard design, storytelling with data, DAX functions. **Case Studies:** Industry use cases and projects using Power BI.	12	CO5

Text Books

1. John W. Creswell, J. David Creswell, *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*, SAGE Publications.
2. Howard S. Becker, *Writing for Social Scientists: How to Start and Finish Your Thesis, Book, or Article*, University of Chicago Press.
3. Ryan Mitchell, *Web Scraping with Python: Collecting More Data from the Modern Web*, O'Reilly Media.
4. Cole Nussbaumer Knaflic, *Storytelling with Data: A Data Visualization Guide for Business Professionals*, Wiley.
5. Brett Powell, *Mastering Microsoft Power BI: Expert Techniques for Effective Data Analytics and Business Intelligence*, Packt Publishing.

Suggested Readings

1. Thomas R. Black, *Doing Quantitative Research in the Social Sciences*, SAGE.
2. Allen B. Downey, *Think Stats: Probability and Statistics for Programmers*, O'Reilly.
3. Cathy O'Neil and Rachel Schutt, *Doing Data Science*, O'Reilly Media.

Web Resources

- https://www.kaggle.com/learn/data-visualization
- https://www.scrapy.org/
- https://powerbi.microsoft.com/en-us/learning/
- https://developers.google.com/web/tools/chrome-devtools
- https://www.storytellingwithdata.com/blog

Course Outcomes (COs) and Cognitive Level Mapping

PDS2MC06	**Research Methodologies for Data Science (MC)**	**Cognitive Levels**
CO1	Understand the fundamental concepts of research methodology and its scope in data science.	K1, K2
CO2	Formulate research problems and conduct effective literature reviews.	K3
CO3	Perform practical web scraping using Python libraries.	K4
CO4	Apply narrative strategies and ethics in data storytelling.	K5
CO5	Design and implement visual analytics using Power BI and DAX.	K6

Course Description

4.5 PDS2MC07 - Machine Learning

Course Code	PDS2MC07
Course Title	Machine Learning
Credits	4
Hours/Week	5
Category	Major Core (MC) – Theory
Semester	II
Regulation	2022

Course Learning Outcome

CLO1	Understand the concepts of Machine learning.
CLO2	Understand and distinguish Supervised, Unsupervised and Reinforcement Learning.
CLO3	Apply Supervised, Unsupervised and Semi-supervised algorithms for a specific problem.
CLO4	Compare the performance of various machine learning techniques for real world problems.
CLO5	Propose solutions for real world problems using huge volume of data.

Course Objectives

CO1	To understand a range of Machine learning algorithms along with their merits and demerits.
CO2	To learn the methodology and apply the machine learning algorithms to real world problems.
CO3	To implement visualization of solutions for effective understanding and decision making.
CO4	To explore the concepts of market basket analysis and recommendation systems.

Prerequisites: Basic knowledge in data science algorithms.

SYLLABUS

UNIT	CONTENT	HRS	COs Mapped
I	Machine Learning Foundations – Overview – Design of a Learning System – Types of Machine Learning – Supervised Learning and Unsupervised Learning – Applications – Tools Overview for ML.	15	CO1–CO5
II	Supervised Learning I: Simple, Multiple and Polynomial Regression – Ridge, Lasso Regression – Evaluating Regression Models – Model Selection – Bagging – Ensemble Methods.	15	CO1–CO5
III	Supervised Learning II: Classification – Logistic Regression – Decision Tree and Random Forest – SVM Regression and Classification – Evaluating Models.	15	CO1–CO5
IV	Unsupervised Learning: Clustering – K-Means – Density-Based Clustering – Dimensionality Reduction – Collaborative Filtering.	15	CO1–CO5
V	Association Rule and Reinforcement Learning – Apriori – Eclat – UCB – Thompson Sampling – Q-Learning.	15	CO1–CO5

Text Books

1. Kevin P. Murphy, *Machine Learning: A Probabilistic Perspective*, MIT Press, 2012.
2. Ethem Alpaydin, *Introduction to Machine Learning*, MIT Press, 3rd Ed., 2014.
3. Tom Mitchell, *Machine Learning*, McGraw-Hill, 1997.
4. Sebastian Raschka, Vahid Mirjilili, *Python Machine Learning and Deep Learning*, 2nd Ed., 2018.
5. Carol Quadros, *Machine Learning with Python, scikit-learn and Tensorflow*, Packt, 2018.
6. Gavin Hackeling, *Machine Learning with scikit-learn*, O'Reilly, 2018.
7. Stanford Lectures by Prof. Andrew Ng.
8. Christopher Bishop, *Pattern Recognition and Machine Learning*, Springer, 2007.

Suggested Readings

1. Samir Madhavan, *Mastering Python for Data Science*, Packt, 2016.
2. Jake VanderPlas, *Python Data Science Handbook*, O'Reilly, 2016.
3. Ethem Alpaydin, *Introduction to Machine Learning*, The MIT Press, 2009.
4. Stanford Lectures of Prof. Andrew Ng.
5. NPTEL Lectures of Prof. B. Ravindra.

Web Resources

- https://data-flair.training/blogs/machine-learning-tutorial/
- https://www.packtpub.com/application-development/complete-machine-learning-course-python-video
- https://www.geeksforgeeks.org/machine-learning/

Course Outcomes (COs) and Cognitive Level Mapping

PDS2MC07	**Machine Learning (MC)**	**Cognitive Levels**
CO1	To understand the concepts of Machine learning.	K1, K2
CO2	To understand and distinguish Supervised, Unsupervised and Reinforcement Learning.	K3
CO3	To apply Supervised, Unsupervised and semi-supervised algorithms for a specific problem.	K4
CO4	To compare the performance of various machine learning techniques.	K5
CO5	To propose solutions using large volumes of data.	K6

Course Description

4.6 PDS2MC08 - Machine Learning - Lab

Course Code	PDS2MC08
Course Title	Machine Learning Lab
Credits	2
Hours/Week	4
Category	Major Core (MC) – Practical
Semester	I
Regulation	2022

Course Learning Outcome

CLO1	Understand the implementation of Machine Learning concepts.
CLO2	Develop programming skills using Python.
CLO3	Analyze the Supervised, Unsupervised and Reinforcement Learning problems.
CLO4	Choose appropriate algorithms for real world problems.
CLO5	Solve problems using various machine learning algorithms.

Course Objectives

CO1	To implement various machine learning algorithms.
CO2	To analyze the working of machine learning algorithms.
CO3	To build recommendation systems.
CO4	To improve the accuracy and efficiency of machine learning algorithms.

Prerequisites: Basic knowledge in Python and Machine Learning.

SYLLABUS – PRACTICAL

UNIT	CONTENT	HRS	COs Mapped
I	1. Introduction to Machine Learning using Python 2. Data Exploration and Visualization 3. Simple Linear Regression 4. Multiple Linear Regression 5. Polynomial Regression	12	CO1–CO4
II	6. Ridge Regression 7. Lasso Regression 8. Logistic Regression 9.Decision Tree Classification 10. Random Forest Classification	12	CO1–CO4
III	11. Support Vector Regression and Classification 12. K-Nearest Neighbors 13. Naive Bayes 14. K-Means Clustering 15. Hierarchical Clustering	12	CO1–CO4
IV	16. Principal Component Analysis (PCA) 17. Kernel PCA 18.Linear Discriminant Analysis (LDA) 19. t-SNE	12	CO1–CO4
V	20. Association Rule Learning – Apriori 21. Eclat Algorithm 22. Reinforcement Learning – Upper Confidence Bound (UCB) 23. Thompson Sampling 24. Q-Learning	12	CO1–CO4

Text Books

1. Kevin P. Murphy, *Machine Learning: A Probabilistic Perspective*, MIT Press, 2012.
2. Ethem Alpaydin, *Introduction to Machine Learning*, MIT Press, 3rd Ed., 2014.
3. Tom Mitchell, *Machine Learning*, McGraw-Hill, 1997.
4. Sebastian Raschka, Vahid Mirjilili, *Python Machine Learning and Deep Learning*, 2nd Ed., 2018.
5. Gavin Hackeling, *Machine Learning with scikit-learn*, O'Reilly, 2018.

Suggested Readings

1. Samir Madhavan, *Mastering Python for Data Science*, Packt, 2016.
2. Jake VanderPlas, *Python Data Science Handbook*, O'Reilly, 2016.
3. Stanford Lectures of Prof. Andrew Ng.
4. NPTEL Lectures of Prof. B. Ravindra.

Web Resources

- https://data-flair.training/blogs/machine-learning-tutorial/
- https://www.packtpub.com/application-development/complete-machine-learning-course-python-video
- https://www.geeksforgeeks.org/machine-learning/

Course Outcomes (COs) and Cognitive Level Mapping

PDS2MC08	**Machine Learning Lab (MC)**	**Cognitive Levels**
CO1	To implement various machine learning algorithms.	K1, K2
CO2	To analyze the working of machine learning algorithms.	K3
CO3	To build recommendation systems.	K4
CO4	To improve the accuracy and efficiency of ML algorithms.	K5

Course Description

4.7 PDS2ME01-Marketing Analytics

Course Code	PDS2ME01
Course Title	Marketing Analytics
Credits	2
Hours/Week	4
Category	Major Elective (ME) – Theory
Semester	II
Regulation	2022

Course Learning Outcome

CLO1	Analyze various types of marketing data and interpret patterns and insights.
CLO2	Evaluate the quality of marketing data and its applications in strategic decisions.
CLO3	Apply segmentation and customer analytics methods including CLV and churn prediction.
CLO4	Use social media platforms and tools to derive marketing strategies and measure campaign impact.
CLO5	Apply web analytics techniques and tools (e.g., Google Analytics) for digital marketing insights.

Course Objectives

CO1	Recognize challenges in working with marketing data sets.
CO2	Identify and apply algorithms for analyzing social media and web data.
CO3	Select suitable models for machine learning tasks in marketing analytics.

Prerequisites: Basic knowledge in statistics and data analysis.

SYLLABUS

UNIT	CONTENT	HRS	COs Mapped
I	**Marketing Analytics Basics:** Introduction, Data for Marketing Analytics, BI and Data Science, EDA, Descriptive, Predictive, and Prescriptive Analytics. Price Analytics: Bundling, Skimming, Promotions, Discounts.	8	CO1–CO5
II	**Customer Analytics:** Segmentation, Cluster Analysis, Metrics for Customer Experience, Logistic Regression, CLV, Churn Analytics.	14	CO1–CO5
III	**Digital Marketing Analytics:** Traditional vs Digital Marketing, Display Ads, CPC, CPM, CPL, CPA, Digital Ad Models. Strategy development for social media.	14	CO1–CO5
IV	**Social Media Analytics:** Facebook Ads, Insights, Hashtags, Case Study: Tata Docomo. Twitter Ads and Tools.	12	CO1–CO5
V	**Web Analytics:** Web Logs, JavaScript Tags, Multi-channel Attribution, Tracking Codes, Google Analytics, AdWords, Mobile and Universal Analytics.	12	CO1–CO5

Text Books

1. Seema Gupta, Avadoot Jather, *Marketing Analytics*, Wiley, 2021.
2. Seema Gupta, *Digital Marketing*, McGraw-Hill, 2018.
3. Chuck Hemann, Ken Burbary, *Digital Marketing Analytics*, Pearson, ISBN: 9780789750303.
4. Matthew Ganis, Avinash Kohirkar, *Social Media Analytics*, Pearson, 2016.
5. Jim Sterne, *Social Media Metrics*, Wiley, 2020.
6. Marshall Sponder, *Social Media Analytics*, McGraw Hill, Latest Edition.

Suggested Readings

1. Mike Grigsby, *Marketing Analytics: A Practical Guide to Real Marketing Science*, Kogan Page.
2. Bendle, Farris, Pfeifer, Reibstein, *Marketing Metrics 3e.*
3. Raj Kumar Venkatesan, Paul Farris, Ronald T. Wilcox, *Cutting Edge Marketing Analytics*, Pearson.

Web Resources

- https://www.smartinsights.com/
- https://analytics.google.com/analytics/academy/
- https://www.hubspot.com/
- https://moz.com/learn/seo/what-is-seo
- https://buffer.com/resources/

Course Outcomes (COs) and Cognitive Level Mapping

PDS2ME01	**Marketing Analytics (ME)**	**Cognitive Levels**
CO1	Understand the fundamental concepts of Marketing Analytics.	K1, K2
CO2	Apply descriptive and predictive analytics to marketing scenarios.	K3
CO3	Perform segmentation and customer analytics using data models.	K4
CO4	Analyze and evaluate Facebook and Twitter analytics tools.	K5
CO5	Apply web analytics platforms and track user engagement data.	K6

Course Description

4.8 PDS2ME02-Health Analytics

Course Code	PDS2ME02
Course Title	Health Analytics
Credits	2
Hours/Week	4
Category	Major Elective (ME) – Theory
Semester	II
Regulation	2022

Course Learning Outcome

CLO1	Analyze various types and sources of healthcare data, including clinical, operational, and patient-generated data.
CLO2	Evaluate data quality and interpret healthcare data based on source and use-case.
CLO3	Compare and apply common data models and analytic techniques used in healthcare.
CLO4	Implement predictive models using clinical, genomic, and temporal healthcare data.
CLO5	Identify techniques for fraud detection and personalized treatment in healthcare systems.

Course Objectives

CO1	To understand the basic sources of healthcare data.
CO2	To perform biomedical image and sensor data analysis.
CO3	To apply NLP and mine healthcare-related social media data.
CO4	To build advanced predictive and prescriptive analytic models.
CO5	To explore fraud detection and assistive technologies in healthcare.

Prerequisites: Basic knowledge in statistics and data analysis.

SYLLABUS

UNIT	CONTENT	HRS	COs Mapped
I	**Introduction to Healthcare Data Analytics:** Electronic Health Records (EHR), Components of EHR, Coding Systems, Benefits and Barriers to EHR, Challenges, Phenotyping Algorithms.	8	CO1–CO5
II	**Biomedical and Sensor Data Analysis:** Biomedical Image Analysis, Sensor Data Mining, Biomedical Signal Analysis, Genomic Data Analysis for Personalized Medicine.	14	CO1–CO5
III	**Text and Social Media Mining:** NLP and Data Mining for Clinical Text, Biomedical Social Media Analytics for Healthcare.	14	CO1–CO5
IV	**Advanced Data Analytics:** Clinical Prediction Models, Temporal Data Mining, Visual Analytics, Predictive Models integrating Genomic Data, Information Retrieval, Healthcare Data Publishing Methods.	12	CO1–CO5
V	**Applications and Practical Systems:** Pervasive Health Analytics, Fraud Detection, Pharmaceutical Discoveries, Clinical Decision Support Systems, Medical Image Analysis Systems, Mobile Imaging and Analytics.	12	CO1–CO5

Text Books

1. Chandan K. Reddy and Charu C. Aggarwal, *Healthcare Data Analytics*, Taylor Francis, 2015.
2. Ross M. Muller and Edward M. Rafalski, *Healthcare Analytics*, Routledge, 2020.
3. Chandan K. Reddy, *Healthcare Data Analytics*, CRC Press, 2020.
4. Vikas Kumar, *Healthcare Analytics Made Simple*, Packt, 2020.

Suggested Readings

1. Hui Yang and Eva K. Lee, *Healthcare Analytics: From Data to Knowledge to Healthcare Improvement*, Wiley, 2016.
2. Tim O'Reilly, *How Data Science is Transforming Healthcare*, O'Reilly, 2022.
3. Laura B. Madsen, *Data-Driven Healthcare*, Wiley, 2022.
4. Jason Burke, *Health Analytics*, Wiley, 2020.

Web Resources

- https://www.healthit.gov/
- https://www.kaggle.com/learn/healthcare-analytics
- https://www.ncbi.nlm.nih.gov/pmc/
- https://towardsdatascience.com/tagged/healthcare
- https://data.humdata.org/

Course Outcomes (COs) and Cognitive Level Mapping

PDS2ME02	**Health Analytics (ME)**	**Cognitive Levels**
CO1	Understand sources and characteristics of healthcare data.	K1, K2
CO2	Perform image and genomic data analysis for personalized medicine.	K3
CO3	Apply NLP techniques to analyze clinical and social media healthcare text.	K4
CO4	Design predictive and prescriptive models for clinical data.	K5
CO5	Detect healthcare fraud and implement assistive medical image analysis systems.	K6

5 SEMESTER III

Course Description

5.1 PDS3MC02-Deep Learning

Course Code	PDS3MC02
Course Title	Deep Learning
Credits	4
Hours/Week	4
Category	Major Core (MC) – Theory
Semester	III
Regulation	2022

Course Learning Outcome:

CLO1	This course introduces the foundational concepts of deep learning and its significance in handling high-dimensional data such as images, text, and time-series data.
CLO2	It focuses on building stable and efficient representations using various neural network architectures including CNNs and RNNs.
CLO3	The course emphasizes both theoretical understanding and practical implementation of deep learning algorithms.
CLO4	Learners will explore cutting-edge models such as the Boltzmann Machine and delve into applications in computer vision and multimedia.
CLO5	It provides a broad view of ongoing research trends and prepares students to address real-world challenges using deep learning methods.

Course Objectives

CO1	To understand the foundational concepts of artificial neural networks, including neuron models, activation functions, and gradient-based optimization techniques.
CO2	To explore and implement Convolutional Neural Networks (CNNs) and understand their role in image and feature extraction.
CO3	To understand and build Recurrent Neural Networks (RNNs), including LSTM, and apply them to sequential and time-series data.
CO4	To gain insights into Reinforcement Learning fundamentals, including components, policy evaluation, and the Bellman equation.
CO5	To apply advanced reinforcement learning techniques such as Temporal Difference Learning, Q-learning, and Deep Q-Networks for dynamic decision-making systems.

Prerequisites: Basic Knowledge in linear algebra, and probability theory.

SYLLABUS

UNIT	CONTENT	HRS	COs	COGNITIVE LEVEL
I	**Artificial Neural Networks:** The Neuron, Activation Function, Gradient Descent, Stochastic Gradient Descent, Back Propagation, Business Problem.	12	CO1-CO5	K1-K6
II	**Convolutional Neural Networks:** Convolution Operation, ReLU, Pooling, Flattening, Full Conversion Layer, Softmax and Cross-Entropy.	12	CO1-CO5	K1-K6
III	**Recurrent Neural Networks:** RNN intuition, Vanishing Gradient, LSTM, Building, Evaluating, Improving, and Tuning RNNs.	12	CO1-CO5	K1-K6
IV	**Reinforcement Learning I:** Components of RL System – policy, Agent, Environment, Maze problem, Bellman Equation, Dynamic Programming.	12	CO1-CO5	K1-K6
V	**Reinforcement Learning II:** TD Learning, MDPs, Q-Learning, Deep Q-Learning, Dynamic Policy Determination.	12	CO1-CO5	K1-K6

Text Books

1. Francois Challot, *Deep Learning with Python*, Manning, 2017.
2. Jon Krohn et al., *Deep Learning Illustrated*, September 2022.
3. Ian Goodfellow, *Deep Learning*, MIT Press, 2017.

Suggested Readings

1. Josh Patterson, *Deep Learning: A Practitioner's Approach*, PACKT, 2017.
2. Dipayan Dev, *Deep Learning with Hadoop*, PACKT, 2017.
3. Hugo Larochelle's Video Lectures on Deep Learning.

Web Resources

- https://www.ibm.com/cloud/learn/deep-learning
- https://www.coursera.org/specializations/deep-learning
- https://www.simplilearn.com/tutorials/deep-learning-tutorial

Course Outcomes (COs) and Cognitive Level Mapping

PDS3MC02	Deep Learning (MC)	Cognitive Levels
CO1	To understand the fundamentals of deep learning.	K1, K2
CO2	To improve the research in computer vision and multimedia field.	K3
CO3	To implement, train, and validate their own neural network.	K4
CO4	Be able to design and implement deep neural network systems.	K5
CO5	Be able to identify new application requirements in the field of computer vision.	K6

Course Description

5.2 PDS3MC03-Deep Learning – Lab

Course Code	PDS3MC03
Course Title	Deep Learning – Lab
Credits	3
Hours/Week	4
Category	Major Core (MC) – Lab
Semester	III
Regulation	2022

Course Learning Outcome

CLO1	Understand the setup and application of deep learning libraries including TensorFlow, Keras, and PyTorch.
CLO2	Explore and implement neural network architectures including CNNs and RNNs.
CLO3	Perform advanced image operations such as gradients, contours, and edge detection.
CLO4	Perform experimentation with reinforcement learning models using Bellman equations, policy evaluation, and TD methods.
CLO5	Apply advanced techniques like Q-learning and Deep Q-Learning to real-world inspired environments and interpret outcomes effectively.

Course Objectives

CO1	To develop neural networks for handling sequence and image data.
CO2	To learn hyperparameter tuning in deep learning models.
CO3	To perform image-based operations like gradients, contours, and transformations.
CO4	Gain insights into Reinforcement Learning fundamentals, including components, policy evaluation, and the Bellman equation.
CO5	Apply advanced reinforcement learning techniques such as Temporal Difference Learning, Q-learning, and Deep Q-Networks for dynamic decision-making systems.

Prerequisites: Basic knowledge in Python programming and machine learning techniques.

SYLLABUS

UNIT	CONTENT	HRS	COs Mapped
I	Setting up Spyder IDE, executing Python programs. Installing TensorFlow, Keras, and PyTorch. Implementing basic Artificial Neural Networks.	12	CO1–CO5
II	Developing Convolutional Neural Networks with image and text data. Performing image transformations.	12	CO1–CO5
III	Applying image gradients and edge detection techniques. Performing image contour analysis.	12	CO1–CO5
IV	To implement core reinforcement learning techniques including policy evaluation, Dynamic Programming, and Bellman equations. Build grid-world environments, simulate policies, and compute value functions	12	CO1–CO5
V	Explore Temporal Difference (TD) learning and implement Q-learning for maze problems. Implement Deep Q-Networks (DQNs) in environments like CartPole, focusing on hyperparameter tuning and performance analysis for real-time decision-making systems.	12	CO1–CO5

Text Books

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, *Deep Learning*, MIT Press, 2016.
2. B. Yegnanarayana, *Artificial Neural Networks*, PHI Learning Pvt. Ltd., 2009.
3. G.H. Golub and C.F. Van Loan, *Matrix Computations*, JHU Press, 2013.
4. Satish Kumar, *Neural Networks: A Classroom Approach*, Tata McGraw-Hill Education, 2004.

5. Richard S. Sutton and Andrew G. Barto, *Reinforcement Learning: An Introduction*, MIT Press, 2018.

6. Ian Goodfellow, Yoshua Bengio, and Aaron Courville, *Deep Learning*, MIT Press, 2017.

Suggested Readings

1. Trevor Hastie, Robert Tibshirani, Jerome Friedman, *The Elements of Statistical Learning*, Springer, 2009.

2. Christopher M. Bishop, *Pattern Recognition and Machine Learning*, Springer, 2006.

3. Sebastian Raschka, *Python Machine Learning*, Packt Publishing, 2015.

Web Resources

- http://cs231n.stanford.edu/ – Convolutional Neural Networks for Visual Recognition, Stanford
- https://web.stanford.edu/class/cs224n/ – Deep Learning for NLP, Stanford
- https://rail.eecs.berkeley.edu/deeprlcourse/ – Deep Reinforcement Learning, Berkeley
- http://selfdrivingcars.mit.edu/ – Deep Learning for Self-Driving Cars, MIT
- Python RL Libraries: https://stable-baselines.readthedocs.io/
- OpenAI Gym Environments: https://www.gymlibrary.dev/

Course Outcomes (COs) and Cognitive Level Mapping

PDS3MC03	**Deep Learning – Lab (MC)**	**Cognitive Levels**
CO1	To develop neural networks for handling sequence and image data.	K1, K2
CO2	To perform hyperparameter tuning and training using DL frameworks.	K3
CO3	To perform various image operations such as transformations and gradients.	K4
CO4	To implement advanced neural models for real-world applications.	K5
CO5	To evaluate deep learning models and adapt them for production-ready systems.	K6

Course Description

5.3 PDS3MC04-Cloud Computing

Course Code	PDS3MC04
Course Title	Cloud Computing
Credits	4
Hours/Week	4
Category	Major Core (MC) – Theory
Semester	III
Regulation	2022

Course Learning Outcome

CLO1	Understand cloud computing architecture, service models, and cloud providers.
CLO2	Gain insights into cloud-native application design and microservices architecture.
CLO3	Explore serverless architecture and DevOps tools and practices in cloud computing.
CLO4	Understand cloud data centers, design considerations, and security mechanisms.
CLO5	Analyze and apply cloud services for real-world domains using DAaaS and cloud apps.

Course Objectives

CO1	To identify the basic elements of cloud architecture.
CO2	To familiarize with different cloud service models and deployment types.
CO3	To learn the concepts of serverless computing and DevOps.
CO4	To understand cloud data centers, their evolution, and cloud security challenges.

Prerequisites: Basic knowledge in Computer Science and Internet.

SYLLABUS

UNIT	CONTENT	HRS	COs Mapped
I	**Introduction:** Overview of Cloud Computing, Essential Characteristics, Cloud Architecture, NIST Reference Model, Cloud Operational Models (private, public, hybrid), Service Models (IaaS, PaaS, SaaS), Example vendors (AWS, Azure, GCP, OpenStack).	12	CO1–CO5
II	**Platform Engineering:** Cloud-native and Microservices Design, Containerization, Continuous Delivery, Client support, Monolithic vs Microservices, 12-Factor App Design, Service Discovery and Registry.	12	CO1–CO5
III	**Serverless Architecture and DevOps:** FaaS, BaaS, AWS Lambda and Fargate, Introduction to DevOps, CI/CD, Quality Attributes, DevOps Cloud Models.	12	CO1–CO5
IV	**Cloud Data Centers and Security:** History, Components, Power, Evolution, Cloud Storage (CloudTM), CIA Triad, STRIDE Threat Model, Cryptographic Techniques, Security by Design.	12	CO1–CO5
V	**DAaaS and Cloud Applications:** Hadoop as a Service, MapReduce on Cloud, Chubby Locking Service, AWS SNS, Online Gaming, CDN Applications.	12	CO1–CO5

Text Books

1. Scott Goessling, Kevin L. Jackson, *Architecting Cloud Computing Solutions*, Packt Publishing, 2018.
2. Joseph Ingeno, *Software Architect's Handbook*, Packt Publishing, 2018.
3. Kai Hwang, Geoffrey Fox, Jack J. Dongarra, *Distributed and Cloud Computing: From Parallel Processing to the Internet of Things*, Morgan Kaufmann, 1st Edition, 2011.
4. Gautham Shroff, *Enterprise Cloud Computing: Technology, Architecture, Applications*, Cambridge University Press, 2010.
5. Noah Gift, *Learning Path: AWS Certified Machine Learning – Specialty ML*, April 2022.
6. Eberhard Wolff, *Microservices: Flexible Software Architecture*, Addison-Wesley Professional, 2016.

Suggested Readings

1. Kris Jamsa, *Cloud Computing SaaS, PaaS, Virtualization, Business, Mobile Security and More*, Jones Bartlett, 2014.

2. Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi, *Mastering Cloud Computing*, Tata McGraw-Hill, 2013.

3. Arshdeep Bahga, Vijay Madisetti, *Cloud Computing: A Hands-on Approach*, University Press, 2017.

Web Resources

- https://www.javatpoint.com/cloud-computing-tutorial
- https://www.simplilearn.com/tutorials/cloud-computing-tutorial
- https://nptel.ac.in/courses/106/104/106104182/

Course Outcomes (COs) and Cognitive Level Mapping

PDS3MC04	**Cloud Computing (MC)**	**Cognitive Levels**
CO1	To remember and understand cloud computing services, models, and cloud vendors.	K1, K2
CO2	To understand the characteristics of cloud-native applications and microservices.	K1, K2
CO3	To explore the concept of serverless architecture and DevOps.	K3, K4
CO4	To evaluate the historical perspective of cloud data centers and understand the cloud security considerations.	K5
CO5	To create different use cases of cloud applications in diverse domains.	K6

Course Description

5.4 PDS3MC05-Cloud Computing – Lab

Course Code	PDS3MC05
Course Title	Cloud Computing – Lab
Credits	3
Hours/Week	4
Category	Major Core (MC) – Lab
Semester	III
Regulation	2022

Course Learning Outcome

CLO1	Understand the basic components of cloud platforms such as EC2, Azure, and GCP.
CLO2	Gain hands-on experience in deploying and managing cloud-based applications.
CLO3	Demonstrate proficiency in using Docker and Artifactory in a cloud environment.
CLO4	Apply DevOps principles using pipelines with Git, Jenkins, and Docker.
CLO5	Implement serverless architectures using AWS Lambda, Fargate, and SNS.

Course Objectives

CO1	To explore cloud computing platforms such as Microsoft Azure, AWS, and GCP.
CO2	To provide foundational skills to adopt and implement cloud services and tools.
CO3	To enable students to design and develop cloud applications using DevOps principles.
CO4	To provide practical experience in application deployment using serverless architecture.

Prerequisites: Basic knowledge in programming and networking.

SYLLABUS

UNIT	CONTENT	HRS	COs Mapped
I	1. Create an EC2 Instance and deploy a sample web application. 2. Develop sample web apps in Azure / GCP.	12	CO1–CO4
II	3. Connect Linux instances via SSH and enable SCP file sharing. 4. Deploy a basic web app and enhance with JavaScript features.	12	CO1–CO4
III	5. Install and configure Docker; run multiple images locally. 6. Create a Docker repo/artifactory; execute push/pull commands.	12	CO1–CO4
IV	7. Deploy library automation on the cloud using DevOps practices. 8. Create a simple Git–Jenkins–Docker pipeline.	12	CO1–CO4
V	9. Build serverless applications using AWS Lambda or AWS Fargate. 10. Use Amazon SNS for cloud-based messaging.	12	CO1–CO4

Text Books

1. John Rhoton and Risto Haukioja, *Cloud Computing Architectured: Solution Design Handbook*, Recursive Press, 2013.
2. Dinkar Sitaram and Geetha Manjunathan, *Moving to the Cloud: Developing Apps in the New World of Cloud Computing*, Syngress, 2012.

Suggested Readings

1. Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi, *Mastering Cloud Computing*, Tata McGraw-Hill, 2013.
2. Anthony T. Velte, Toby J. Velte, Robert Elsenpeter, *Cloud Computing: A Practical Approach*, Tata McGraw-Hill, 2010.
3. Barrie Sosinsky, *Cloud Computing Bible*, Wiley Publishing.

Web Resources

- https://cloud.google.com/appengine/docs
- https://www.chef.io/solutions/cloud-management/
- https://aws.amazon.com/documentation
- https://www.cloudfoundry.org/
- https://puppet.com/blog/implement-a-message-queue-your-cloud-application

Course Outcomes (COs) and Cognitive Level Mapping

PDS3MC05	**Cloud Computing – Lab (MC)**	**Cognitive Levels**
CO1	Explore cloud computing platforms like Azure, AWS, and GCP.	K1, K2
CO2	Develop and deploy applications on cloud environments.	K3
CO3	Manage containers using Docker and Artifactory.	K4
CO4	Build serverless applications and DevOps pipelines.	K5, K6

Course Description

5.5 PDS3MC06 – Artificial Intelligence

Course Code	PDS3MC06
Course Title	Artificial Intelligence
Credits	3
Hours/Week	4
Category	Major Core (MC) – Theory
Semester	III
Regulation	2022

Course Learning Outcome

CLO1	Demonstrate understanding of AI, Large Language Models, and Foundation Models.
CLO2	Explain various applications of Prompt Engineering techniques.
CLO3	Become aware of Retrieval-Augmented Generation and AI Agents.
CLO4	Get familiar with the finetuning of Foundation Models.
CLO5	Become proficient with AI Engineering Architecture.

Course Objectives

CO1	Gain a historical perspective of Artificial Intelligence, including the evolution of Large Language Models (LLMs) and Foundation Models.
CO2	Understand the principles of Prompt Engineering and its role in enhancing AI systems.
CO3	Explore Retrieval-Augmented Generation (RAG) and the functionality of AI agents.
CO4	Learn techniques for finetuning and adapting Foundation Models for specific applications.
CO5	Examine the architecture, design considerations, and engineering challenges of deploying AI systems.

Prerequisites: Basic understanding of Machine Learning.

SYLLABUS

UNIT	CONTENT	HRS	COs Mapped
I	**AI Engineering:**Language Models – LLMs – Foundation Models – Reasons for current growth of AI – AI Engineering Stack – AI Engineering vs ML Engineering – AI Engineering vs Full-stack Engineering – AI Engineering Techniques.	12	CO1
II	**Prompt Engineering:** Prompting – Parts of a Prompt – In-context Learning – Zero-shot and Few-shot Scenarios – System Prompt and User Prompt – Prompt Engineering Best Practices – Defensive Prompt Engineering – Jailbreaking and Prompt Injection – Defences against Prompt Attacks.	12	CO2
III	**RAG and Agentic AI:** Retrieval-Augmented Generation – RAG Architecture – Retrieval Algorithms – RAG with Tabular Data – AI Agents – Tools: Knowledge, augmentation, capability extension, write actions – Plan Generation – Function Calling.	12	CO3
IV	**Finetuning Foundation Models:**Adaptation of Foundation Models by Finetuning – Instruction-following Ability – Finetuning and Transfer Learning – Self-supervised Finetuning – Finetuning and RAG – Finetuning Techniques – PEFT Techniques – LoRA Technique – Finetuning Methods.	12	CO4
V	**AI engineering Architecture:**Architecture for a Foundation Model Application – Highlights and Challenges – Context Construction – Input and Output Guardrails – Routers and Gateways for AI Applications – Latency and Cost Reduction – Agent Patterns – AI Pipeline Orchestration – User Feedback Utilization.	12	CO5

Text Books

1. Chip Huyen, *Artificial Intelligence Engineering*, O'Reilly, 2024.

References

1. Stuart J. Russell and Peter Norvig, *Artificial Intelligence: A Modern Approach*, Pearson Education Asia, 2nd Edition, 2015.

2. Rajendra Akerkar, *Introduction to Artificial Intelligence*, Prentice Hall of India, 2005.

Web Resources

- https://www.deeplearning.ai/
- https://huggingface.co/
- https://platform.openai.com/docs/

Course Outcomes (COs) and Cognitive Level Mapping

PDS3MC06	**Artificial Intelligence (MC)**	**Cognitive Levels**
CO1	Demonstrate understanding of AI, LLMs, and Foundation Models.	K1, K2
CO2	Explain Prompt Engineering and its applications.	K3
CO3	Understand Retrieval-Augmented Generation and AI Agents.	K4
CO4	Apply knowledge to finetune Foundation Models.	K5
CO5	Design and analyze AI Engineering Architectures.	K6

Course Description

5.6 PDS3ME01-Generative AI – Lab

Course Code	PDS3ME01
Course Title	Generative AI – Lab Exercises
Credits	2
Hours/Week	4
Category	Major Elective (ME) – Practical
Semester	III
Regulation	2022

Course Learning Outcome

CLO1	Understand the foundational principles of generative AI and its applications.
CLO2	Gain hands-on experience with text-to-image and object detection models.
CLO3	Develop practical skills in building AI-powered generators for text, summaries, and recipes.
CLO4	Apply generative AI techniques to multi-modal systems and real-world business use cases.
CLO5	Design and implement conversational agents and summarization tools using state-of-the-art AI models.

Course Objectives

CO1	Introduce learners to the core concepts and tools used in generative AI.
CO2	Enable students to implement various generative models across vision, text, and multi-modal domains.
CO3	Provide exposure to prompt engineering and fine-tuning large models for specific tasks.
CO4	Equip learners with the skills to build real-time generative AI applications.
CO5	Encourage application of generative AI to solve practical industry problems through mini-projects and case studies.

Prerequisites: Basic knowledge of Python programming, machine learning, and neural networks.

SYLLABUS

Ex. No.	Title of Exercise	Hours	COs Mapped
1	Text-To-Image Generator using diffusion models (e.g., Stable Diffusion)	3	CO1, CO2
2	Face Mask Detection using pre-trained models	3	CO2
3	Object Detection in Images using YOLOv5 or similar	3	CO2, CO4
4	Image Caption Generator using CNN + LSTM models	3	CO2, CO3
5	Multi-Modal AI Assistant using OpenAI API or similar frameworks	3	CO3, CO4
6	Summary Generator for large documents using transformer-based models	3	CO3, CO5
7	Recipe Generator using LLM-based prompt engineering	3	CO3, CO4
8	Python Code Generator using code-specific AI models (e.g., CodeX, CodeWhisperer)	3	CO3, CO4
9	Conversation Generator using fine-tuned ChatGPT-style models	3	CO3, CO5
10	Web Page Summarizer using NLP pipelines and browser scraping	3	CO4, CO5
11	**Case Study 1:** Company Brochure Generator	3	CO4, CO5
12	**Case Study 2:** AI Airline Assistance Application	3	CO4, CO5

Text Books

1. Kelleher, J.D., *Deep Learning*, MIT Press, 2019.
2. Max Tegmark, *Life 3.0: Being Human in the Age of Artificial Intelligence*, Penguin, 2017.
3. Sandro Skansi, *Introduction to Deep Learning: From Logical Calculus to Artificial Intelligence*, Springer, 2020.

Suggested Readings

1. Sebastian Raschka, *Python Machine Learning*, 3rd edition, PACKT, 2019.
2. Jason Brownlee, *Deep Learning with Python*, Machine Learning Mastery, 2017.
3. OpenAI, Hugging Face, and Stability AI documentation.

Web Resources

- https://platform.openai.com/docs
- https://huggingface.co/docs
- https://pytorch.org/tutorials/
- https://keras.io/examples/
- https://stability.ai/blog

Course Outcomes (COs) and Cognitive Level Mapping

PDS3ME01	**Generative AI – Lab Exercises (ME)**	**Cognitive Levels**
CO1	Introduce learners to the core concepts and tools used in generative AI.	K1, K2
CO2	Implement generative models for vision and detection tasks.	K3
CO3	Build NLP-based generators for summaries, conversations, and recipes.	K4
CO4	Apply generative AI to multi-modal and interactive use cases.	K5
CO5	Design real-world AI projects through case studies and problem-solving.	K6

Course Description

5.7 PDS3ME02-Edge AI – Lab

Course Code	PDS3ME02
Course Title	Edge AI – Lab
Credits	2
Hours/Week	4
Category	Major Elective (ME) – Practical
Semester	III
Regulation	2022

Course Learning Outcome

CLO1	Understand the fundamentals of Edge AI and embedded systems integration.
CLO2	Gain hands-on experience with Raspberry Pi and IoT sensor-based data acquisition.
CLO3	Apply AI models for real-time image processing and predictive maintenance.
CLO4	Build and deploy smart systems using Edge AI in home automation and robotics.
CLO5	Design and execute a capstone project solving a real-world problem with Edge AI.

Course Objectives

CO1	Introduce Edge AI concepts and setup procedures for embedded devices.
CO2	Train students in sensor data collection and home automation using IoT platforms.
CO3	Enable practical implementation of AI for object detection, recognition, and control on edge devices.
CO4	Foster creativity in building and customizing physical enclosures and robotic applications.
CO5	Develop project management and innovation skills through a capstone problem-solving project.

Prerequisites: Basic knowledge of IoT, Python, Linux, and machine learning concepts.

SYLLABUS

Ex.No.	Title of Exercise	Hours	COs Mapped
1	Setting Up Raspberry Pi: OS installation, SSH, VNC, connecting IoT sensors.	3	CO1
2	Basic IoT Sensor Data Collection: Read temperature and humidity data using Raspberry Pi or Arduino.	3	CO1, CO2
3	Smart Home Automation: Use motion sensors to control appliances.	3	CO2, CO4
4	Real-Time Air Quality Monitoring: Collect and visualize data from air quality sensors.	3	CO2
5	Face Recognition System: Deploy lightweight AI model for face recognition.	3	CO3
6	Object Detection with OpenCV: Real-time detection and classification using AI camera.	3	CO3
7	Design and Print a Custom IoT Casing: 3D design and printing for IoT device housing.	3	CO4
8	3D-Printed Robot Arm for Edge AI: Build and program a robotic arm.	3	CO4
9	Deploy Predictive Maintenance System: Use AI to predict machine failures from sensor data.	3	CO3
10	Final Capstone Project: Develop a complete Edge AI solution for smart agriculture, healthcare, or automation.	6	CO5

Text Books

1. Daniel Situnayake and Jenny Plunkett, *AI at the Edge: Solving Real-World Problems with Embedded Machine Learning*, O'Reilly Media.
2. Pethuru Raj, G. Nagarajan, R.I. Minu, *Applied Edge AI: Concepts, Platforms, and Industry Use Cases*, Springer.
3. Javid Taheri, Schahram Dustdar, Shuiguang Deng, *Edge Intelligence: From Theory to Practice*, Springer.

Suggested Readings

1. Alasdair Allan, *Programming the Raspberry Pi: Getting Started with Python*, McGraw-Hill.
2. Donald Norris, *The Internet of Things: Do-It-Yourself Projects with Arduino, Raspberry Pi, and BeagleBone Black*, McGraw-Hill.
3. Raspberry Pi Foundation Documentation: https://www.raspberrypi.org/documentation/

Web Resources

- https://www.edgeimpulse.com/
- https://coral.ai/
- https://opencv.org/
- https://circuitdigest.com/
- https://learn.adafruit.com/

Course Outcomes (COs) and Cognitive Level Mapping

PDS3ME02	**Edge AI – Practical (ME)**	**Cognitive Levels**
CO1	Introduce Edge AI concepts and setup procedures for embedded devices.	K1, K2
CO2	Train students in sensor data collection and home automation using IoT platforms.	K3
CO3	Implement AI applications such as object detection, recognition, and prediction on edge devices.	K4
CO4	Design physical systems (robotic arms, enclosures) integrated with Edge AI logic.	K5
CO5	Develop and deploy real-world solutions through a complete Edge AI capstone project.	K6

Course Description

5.8 PDS3ID01-MEAN Stack

Course Code	PDS3ID01
Course Title	MEAN Stack
Credits	3
Hours/Week	6
Category	Major Core (MC) – Theory
Semester	III
Regulation	2022

Course Learning Outcome

CLO1	Understand the usage of MEAN stack components for full-stack development.
CLO2	Apply Angular JS constructs to build forms, validate input, and use filters.
CLO3	Identify and handle errors using services and form controls.
CLO4	Implement Directives and Controllers for dynamic content rendering.
CLO5	Create and manage data models using MongoDB for real-world applications.

Course Objectives

CO1	To implement forms, inputs, and services using Angular JS.
CO2	To develop simple web applications using Node.js, Angular JS, and Express.
CO3	To implement custom directives and filters and connect to backend services.
CO4	To handle HTTP requests and structure backend logic using Express.
CO5	To implement data models and perform CRUD operations using MongoDB.

Prerequisites: Basic knowledge of HTML5, CSS3, JavaScript, and jQuery.

SYLLABUS

UNIT	CONTENT	HRS	COs Mapped
I	**Introduction to Web Technology and Angular JS:** MVC, Expressions, Directives, Controllers, Modules, ng-model, Forms and Validation, Error Handling, ng-form. *Lab:* (1) Form validation with Angular JS, (2) Modules and controllers, (3) Error handling.	12	CO1–CO5
II	**Directives & Building Databases:** Filters, Angular JS Services, Custom Services, HTTP Services, Custom Directives, Server Interactions, Full-stack Concepts. *Lab:* (1) Custom Directives, (2) Frontend and Backend integration.	12	CO1, CO3–CO5
III	**Node.js and Express Framework:** Terminal, HTTP Module, Views, Layouts, Form Handling with Express, Request/Response, Handlebars. *Lab:* (1) Web app using Node.js, Express, Angular JS, (2) Handlebars integration.	12	CO1–CO5
IV	**Introduction to MongoDB:** JSON, NoSQL, CRUD Operations, Collections, Key-Value Pairs, Indexing. *Lab:* (1) Implement CRUD in MongoDB.	12	CO1–CO5
V	**Data Models:** Designing Models, Indexing, Inserting, Querying, Updating, Deleting, Referencing Databases. *Lab:* (1) Data model design and application integration.	12	CO1–CO5

Text Books

1. Simon Holmes, Clive Herber, *Getting MEAN with Mongo, Express, Angular, and Node*, Manning Publications, 2022.
2. Agus Kurniawan, *AngularJS Programming by Example*, PE Press, 2014.
3. David Hows, Peter Membrey, Eelco Plugge, *MongoDB Basics*, Apress, 2014.
4. Ethan Brown, *Web Development with Node and Express*, O'Reilly Media, 2014.

Suggested Readings

1. Colin J. Ihrig, Adam Bretz, *Full Stack JavaScript Development with MEAN: MongoDB, Express, AngularJS, and Node.JS*, SitePoint Pty, 2015.

Web Resources

- https://www.geeksforgeeks.org/introduction-to-mean-stack/
- https://www.javatpoint.com/mean-stack-tutorial
- https://www.sitepoint.com/introduction-mean-stack/

Course Outcomes (COs) and Cognitive Level Mapping

PDS3ID01	**MEAN Stack (MC)**	**Cognitive Levels**
CO1	To understand the usage and structure of MEAN Stack.	K1, K2
CO2	To apply programming constructs to create forms, validate input, and use filters.	K3
CO3	To illustrate error identification and handling in web apps.	K4
CO4	To implement Directives and Controllers for dynamic rendering.	K5
CO5	To design and implement data models for real-world applications using MongoDB.	K6

6 SEMESTER II

6.1 PDS2CD01 – Cross Disciplinary:Data Visualization through R

Course Code	PDS3VA01
Course Title	Cross Disciplinary:Data Visualization through R
Credits	1
Hours/Week	2
Category	Major Core (MC) – Theory
Semester	II
Regulation	2022

Course Learning Outcome

CLO1	Use RStudio to perform basic data analysis functions including Input/Output, basic Exploratory Data Analysis (EDA), and graphical output.
CLO2	Use RStudio to develop, test, and execute R script.
CLO3	Use advanced R programming to import, clean, transform, and summarize data.
CLO4	Use ggplot2 to visualize data in points, lines, area charts and smoothed curves.
CLO5	Import and map spatial data using R sf and ggplot2 packages.

Course Objectives

CO1	Use RStudio to perform basic data analysis functions including Input/Output, basic Exploratory Data Analysis (EDA), and graphical output.
CO2	Use RStudio to develop, test, and execute R script.
CO3	Use advanced R programming to import, clean, transform, and summarize data.
CO4	Use ggplot2 to visualize data in points, lines, area charts and smoothed curves.
CO5	Import and map spatial data using R sf and ggplot2 package.

Prerequisites: No prerequisites.

SYLLABUS

UNIT	CONTENT	HRS	COs Mapped
I	Introduction to R – Help Functions in R – Vectors – Vectorized Operations – Functions in R – Packages in R.	9	CO1–CO5
II	Matrix Operations – Adding and Deleting Rows and Columns – Higher Dimensional Arrays – Lists – General List Operations – Accessing List Components and Values – Applying functions to Lists.	9	CO1–CO5
III	Creating Data Frames – Matrix-like Operations on a Data Frame – Merging Data Frames – Applying functions to Data Frames – Factors and Tables – Common Functions used with Factors – Working with Tables.	9	CO1–CO5
IV	OOP: S3 and S4 Classes – Managing Objects – Input/Output – Reading/Writing Files – Internet Access – String Manipulation – ggplot2: Visualization of non-spatial data.	9	CO1–CO5
V	Introduction to ggplot2 – Factors – Aesthetics – Layers – Overriding Aesthetics – Mapping vs Setting – Histograms – Density Charts – Statistical Transformations – Facets – Coordinates – Themes.	9	CO1–CO5

Text Books

1. Hadley Wickham, *ggplot2: Elegant Graphics for Data Analysis* (2nd Edition), Springer, 2016.
2. Hadley Wickham and Garrett Grolemund, *R for Data Science*, O'Reilly, 2016.
3. Robin Lovelace, Jakub Nowosad, Jannes Muenchow, *Geocomputation with R*, 2019. Available at https://geocompr.robinlovelace.net/.
4. Robert J., *Spatial Data Science with R.*

Course Outcomes (COs) and Cognitive Level Mapping

PDS2CD01	Data Visualization through R (MC)	Cognitive Levels
CO1	Use RStudio to perform basic data analysis functions including Input/Output, basic Exploratory Data Analysis (EDA), and graphical output.	K1, K2
CO2	Use RStudio to develop, test, and execute R script.	K3
CO3	Use advanced R programming to import, clean, transform, and summarize data.	K4
CO4	Use ggplot2 to visualize data in points, lines, area charts and smoothed curves.	K5
CO5	Import and map spatial data using R sf and ggplot2 packages.	K6

7 SEMESTER III

7.1 PDS3VA01 – Interdisciplinary: Statistics for Computer Science

Course Code	PDS3VA01
Course Title	Interdisciplinary: Statistics for Computer Science
Credits	3
Hours/Week	6
Category	IDE
Semester	III
Regulation	2022

Course Learning Outcome

CLO1	Concepts of descriptive Statistics and definitions.
CLO2	Problems in correlation and regression and its interpretation.
CLO3	Frame appropriate model and test its significance.
CLO4	Perform Factor analysis and its efficiency.
CLO5	Data reduction and feature selection using discriminant analysis.

Course Objectives

CO1	To perform Explanatory data analysis.
CO2	To study the relationship between the features and develop a model.
CO3	To apply statistical techniques and derive factors.
CO4	To perform dimension reduction and feature selection and fine tune the precision of the model.
CO5	To enable the application of multivariate statistical techniques in computer science contexts.

Prerequisites: Basic understanding of Statistics.

SYLLABUS

UNIT	CONTENT	HRS	COs Mapped
I	Sampling Techniques – Data Classification – Tabulation – Frequency and Graphic Representation – Measures of Central Tendency – Measures of Variation – Quartiles and Percentiles – Moments – Skewness and Kurtosis.	14	CO1–CO5
II	Scatter Diagram – Karl Pearson's Correlation Coefficient – Rank Correlation – Correlation Coefficient for Bivariate Frequency Distribution – Regression Coefficients – Fitting of Regression Lines.	15	CO1–CO5
III	Statistical Tests of Significance – Test of significance for means, variances, correlation coefficients, regression coefficients, based on t, Chi-square and F-distributions – Applications of Chi-square in test of significance (independence of attributes, goodness of fit).	15	CO1–CO5
IV	Introduction to Factor Analysis – Meaning, Objectives and Assumptions – Designing a Factor Analysis Study – Deriving Factors – Assessing Overall Factors – Validation of Factor Analysis.	15	CO1–CO5
V	Introduction to Discriminant Analysis – Concepts, Objectives and Applications – Procedure for conducting Discriminant Analysis – Stepwise Discriminant.	15	CO1–CO5

Text Books

1. S.C. Gupta and V.K. Kapoor, *Fundamentals of Mathematical Statistics*, Sultan Chand Sons, 11th Edition, 2002.

2. Joseph F. Hair, William C. Black et al., *Multivariate Data Analysis*, Pearson Education, 7th Edition, 2013.

3. T. W. Anderson, *An Introduction to Multivariate Statistical Analysis*, 3rd Edition, Wiley, 2003.

Suggested Readings

1. James D. Miller, *Statistics for Data Science*, Packt, 2017.

2. Chatfield C., A.J. Collins, *Introduction to Multivariate Analysis*, Springer Nature, 2020.

3. Dawn Iacobucci, *Multivariate Statistics and Marketing Analytics*, 2014.

4. https://onlinecourses.nptel.ac.in/noc22$_mg$87/*preview*

Course Outcomes (COs) and Cognitive Level Mapping

PDS3VA01	**Statistics for Computer Science (IDE)**	**Cognitive Levels**
CO1	Concepts of descriptive Statistics and definitions.	K1, K2
CO2	Problems in correlation and regression and its interpretation.	K3
CO3	Frame appropriate model and test its significance.	K4
CO4	Perform Factor analysis and its efficiency.	K5
CO5	Data reduction and feature selection using discriminant analysis.	K6