PERIYAR UNIVERSITY

PERIYAR PALKALAI NAGAR SALEM 636 011

MASTER OF SCIENCE IN DATA SCIENCE

SEMESTER PATTERN

Under Choice Based Credit System

REGULATIONS AND SYLLABUS

FOR AFFILIATED COLLEGES

(Effective from the Academic year 2026 - 2027 onwards)

PERIYAR UNIVERSITY, SALEM – 636 011

M.Sc. DATA SCIENCE

REGULATIONS AND SYLLABUS – 2026 – 2027

(Affiliated Colleges)

Effective from the Academic year 2026 - 2027 onwards

MASTER OF SCIENCE IN DATA SCIENCE (M.Sc., Data Science)

The Master of Science in Data Science is a postgraduate programme that equips students with the knowledge and skills required to extract meaningful insights from large and complex datasets using statistical, computational, and analytical techniques. The curriculum integrates concepts from mathematics, statistics, computer science, and domain-specific applications, covering areas such as data mining, machine learning, big data analytics, data visualization, and database systems. The programme is structured to help students understand the complete data science pipeline, from data collection and preprocessing to model building, evaluation, and deployment.

Recognizing the growing demand for data-driven decision-making across industries, the programme places strong emphasis on practical exposure through projects, case studies, and hands-on training with industry-relevant tools and platforms. Students are trained to apply data science methodologies to solve real-world problems in domains such as business, healthcare, finance, and social sciences. Upon completion, graduates are expected to be proficient in data analysis, predictive modelling, and the ethical handling of data, making them well-prepared for roles as data scientists, data analysts, and machine learning engineers in a wide range of sectors.

A) OBJECTIVE OF THE PROGRAMME

To develop the Post Graduate in Data Science with strong statistical, computational, and machine learning foundations, combined with practical data engineering and analytical skills, enabling employment in data-driven research, analytics, and industry roles, as well as preparing students for advanced research in academia.

B) CONDITIONS FOR ADMISSION

A candidate who has passed B.Sc. Computer Science / B.Sc. Data Science / B.Sc. Statistics / B.Sc. Mathematics / BCA / B.Sc. Information Technology / B.Sc. Artificial Intelligence and Data Science / B.Sc. Information Science degree of this University, or any other degree accepted by the Syndicate as equivalent thereto, subject to such conditions as may be prescribed, shall be permitted to appear and

qualify for the M.Sc. Data Science degree examination of this University after a course of study of two academic years.

C) DURATION OF THE PROGRAMME

The programme for the degree of Master of Science in Data Science shall consist of two academic years divided into four semesters.

D) EXAMINATIONS

The examination shall be of three hours duration for each course at the end of each semester. A candidate failing in any course(s) will be permitted to appear in the subsequent examination. The practical / project work should be individual work, and the University examination for practical / project work will be conducted jointly by the internal and external examiners at the end of the respective semester.

E) PROGRAMME OUTCOMES (POs) AND PROGRAMME SPECIFIC OUTCOMES (PSOs)

PO1: Computational and Statistical Knowledge: Apply statistical theory, algorithmic structures, and data engineering principles to design robust, scalable data science solutions.

PO2: Problem Analysis & Design: Identify, analyze, and formulate complex data problems, designing analytical pipelines, predictive models, and data systems to meet industry specifications.

PO3: Modern Tool Usage: Master advanced computational tools and environments including Python data engineering libraries, deep learning frameworks, MLOps orchestration tools, and visualization platforms.

PO4: Professional Ethics & Human Rights: Adhere to regulatory, corporate compliance, data privacy laws, and ethical standards in AI deployment, data handling, and research documentation while valuing fundamental human rights.

PO5: Innovation & Lifelong Learning: Engage in continuous professional evolution by executing independent data science research projects, end-to-end model deployment, and adaptation to transformative emerging technologies like generative AI.

PSO1: Data Analysis & Modeling: Design, develop, and validate statistical and machine learning models to extract actionable insights from structured and unstructured data.

PSO2: Data Systems & Emerging Technologies: Apply knowledge of distributed data systems, deep learning, big data engineering, and cloud-based emerging technologies to solve real-world data problems.

PSO3: Research & Innovation: Conduct independent data science research, document findings professionally, and adapt to evolving technologies through continuous self-directed learning.

PSO4: Professional & Industry Readiness: Demonstrate ethical, collaborative, and industry-relevant competencies, including proficiency with modern data science tools, for employability and entrepreneurship.

F) METHODS OF EVALUATION AND METHODS OF ASSESSMENT

Methods of Evaluation:

Component	**Marks**
Continuous Internal Assessment Test	10 Marks
Assignments / Seminar / Quiz	10 Marks
Attendance and Class Participation	5 Marks
Internal Total	**25 Marks**
End Semester Examination	75 Marks
Grand Total	**100 Marks**

Methods of Assessment (Bloom's Taxonomy Levels):

Level	**Description**
Remembering (K1)	The lowest level of questions requires students to recall information from the course content, define terminologies, list core properties, or state foundational formulas without manipulation.
Understanding (K2)	Students comprehend, organize, compare, and interpret facts and ideas in their own words, going beyond recall to explain workflows, illustrate concepts, or contrast analytical approaches.
Application (K3)	Students apply concepts learned in the classroom to solve problems, using structured principles to write code, execute queries, or calculate precise analytical outcomes.
Analyze (K4)	Students break a problem into its component parts, identify reasons, causes, or dependencies, and investigate model failures, isolate bugs, or dissect complex statistical relationships.
Evaluate (K5)	Students make reasoned judgments on the value of an idea, design, or solution, engaging in decision-making and problem-solving where questions may not have a single right answer.
Create (K6)	Students engage in original thinking, assembling diverse elements into a new

	functional pipeline, designing custom analytical frameworks or novel data science solutions.

The Passing minimum shall be 50% out of 75 marks (38 marks) in the End Semester Examination for theory courses.

G) STRUCTURE OF M.Sc. (DATA SCIENCE) PROGRAMME

Course Code	Title of the Course	Credits	Hours		Maximum Marks		
			Theory	Practical	CIA	EA	Total
FIRST SEMESTER							
26MDS01	Core Paper I – Database Systems and Data Warehousing	5	6		25	75	100
26MDS02	Core Paper II – Statistical Machine Learning	5	6		25	75	100
26MDSE01/02	Elective Paper I (Information Retrieval and Web Search Engines / Social Network Analysis and Graph Databases)	4	6		25	75	100
26MDSP01	Practical I – Database Systems and Data Warehousing Lab	4		4	40	60	100
26MDSP02	Practical II – Statistical Machine Learning Lab	4		4	40	60	100
26MDSS01	Skill Enhancement Course I – Cyber Security and Data Privacy	2	4		25	75	100
	Total	**24**	22	**8**			**600**
SECOND SEMESTER							
26MDS03	Core Paper III – Python Programming for Data Science	5	6		25	75	100
26MDS04	Core Paper IV – Deep Learning and Generative AI	5	6		25	75	100
26MDSE03/04	Elective Paper II (Bioinformatics and Health Informatics / Edge AI and IoT Analytics)	4	6		25	75	100

26MDSP03	Practical III – Python Programming for Data Science Lab	4		4	40	60	100
26MDSP04	Practical IV – Deep Learning and Generative AI Lab	4		4	40	60	100
26MDSN01	Non-Major Elective Course I – Data Literacy and Everyday Business Analytics	2	3		25	75	100
26MHR01	Fundamentals of Human Rights	1	1		100	-	100 (Internal)
	Total	**25**	**22**	**8**			**700**
THIRD SEMESTER							
26MDS05	Core Paper V – Big Data Engineering	5	6		25	75	100
26MDS06	Core Paper VI – Digital Image Processing and Computer Vision	5	6		25	75	100
26MDSE05/06	Elective Paper III (Spatial-Temporal Data Mining and GIS Analytics / Cloud Native Computing and Virtualization)	4	6		25	75	100
26MDSP05	Practical V – Big Data Engineering Lab	4		4	40	60	100
26MDSP06	Practical VI – Digital Image Processing and Computer Vision Lab	4		4	40	60	100
26MDSS03	Skill Enhancement Course III – Data Visualization Tools Laboratory (Tableau / Power BI)	2		2	40	60	100
26MDSN02	Non-Major Elective Course II – Artificial Intelligence Ethics, Trends, and Digital	2	2		25	75	100

	Society						
26MDSI01	Contextual Learning: Internship	1			-	-	Commended /Highly Commended
	Total	**27**	**20**	**10**			**700**
FOURTH SEMESTER							
26MDS07	Core Paper VII – Artificial Intelligence Frameworks and MLOps	5	6		25	75	100
26MDSP07	Practical VII – AI Tools, Frameworks, and MLOps Lab	4		4	40	60	100
26MDSPR01	Project with Viva Voce	5		16	50	150	200
26MDSS02	Skill Enhancement Course II – UI/UX Design for Data Science (FIGMA)	2	4		25	75	100
26MDSEX01	Extension Activity	1			100	-	100 (Internal)
	Total	**22**	**10**	**20**			**600**

H) ELECTIVES, SKILL ENHANCEMENT, AND NON-MAJOR ELECTIVE COURSES LIST

Core Papers:

26MDS01 – Core Paper I – Database Systems and Data Warehousing
26MDS02 – Core Paper II – Statistical Machine Learning
26MDS03 – Core Paper III – Python Programming for Data Science
26MDS04 – Core Paper IV – Deep Learning and Generative AI
26MDS05 – Core Paper V – Big Data Engineering
26MDS06 – Core Paper VI – Digital Image Processing and Computer Vision
26MDS07 – Core Paper VII – AI Tools, Frameworks, and MLOps

Practical Papers:

26MDSP01 – Practical I – Database Systems and Data Warehousing Lab
26MDSP02 – Practical II – Statistical Machine Learning Lab
26MDSP03 – Practical III – Python Programming for Data Science Lab
26MDSP04 – Practical IV – Deep Learning and Generative AI Lab

26MDSP05 – Practical V – Big Data Engineering Lab

26MDSP06 – Practical VI – Digital Image Processing and Computer Vision Lab

26MDSP07 – Practical VII – AI Tools, Frameworks, and MLOps Lab

Elective Course – I (choose one):

26MDSE01 – Information Retrieval and Web Search Engines

26MDSE02 – Social Network Analysis and Graph Databases

Elective Course – II (choose one):

26MDSE03 – Bioinformatics, Genomic Data Processing, and Health Informatics

26MDSE04 – Edge AI, IoT Analytics, and Embedded Systems

Elective Course – III (choose one):

26MDSE05 – Spatial-Temporal Data Mining and GIS Analytics

26MDSE06 – Cloud Native Computing and Virtualization

Skill Enhancement Courses:

26MDSS01 – Cyber Security and Data Privacy – Semester I

26MDSS02 – UI/UX Design for Data Science (FIGMA) – Semester IV

26MDSS03 – Data Visualization Tools Laboratory (Tableau / Power BI) – Semester III

Non-Major Elective Courses (offered to other departments):

26MDSN01 – Data Literacy and Everyday Business Analytics – Semester II

26MDSN02 – Artificial Intelligence Ethics, Trends, and Digital Society – Semester III

I) EXTERNAL ASSESSMENT QUESTION PAPER PATTERN (THEORY)

Time: 3 Hours | Maximum Marks: 75

Part A: 15 × 1 = 15 Marks – Answer all questions (three from each unit, Multiple Choice Questions).

Part B: 2 × 5 = 10 Marks – Answer any two questions, one from each unit.

Part C: 5 × 10 = 50 Marks – Answer all questions, one question from each unit (either/or type).

The Passing minimum shall be 50% out of 75 marks (38 marks) in the End Semester Examination for theory courses.

J) CONTINUOUS INTERNAL ASSESSMENT FOR PRACTICAL

Test 1	15 Marks
Test 2	15 Marks
Record	10 Marks
Total	**40 Marks**

Record Note must be compulsorily submitted while attending the Practical Examination. No passing minimum is prescribed for the Record.

K) EXTERNAL ASSESSMENT QUESTION PAPER PATTERN (PRACTICAL)

Exam Duration: 3 Hours; Maximum Marks: 60. Two questions, with or without sub-sections, will be given for the practical examination, each chosen from the question bank prepared by the examiner(s).

Distribution of Marks per Question (30 Marks each):

Problem Understanding: 5 Marks

Program Writing: 10 Marks

Debugging: 10 Marks

Correct Results: 5 Marks

L) ASSESSMENT OF PROJECT WORK

Component	**Marks**
Continuous Internal Assessment	Review I – 25 Marks; Review II – 25 Marks (Total: 50 Marks)
External Assessment	Evaluation & Viva-Voce (Jointly) – 75 Marks

Common instructions for the project work:

- The candidate should submit the filled-in format to the Department for approval during the first week of Semester IV.
- The project should be periodically reviewed.
- The student should submit three copies of the project work.
- Students may use a presentation during the Viva-Voce examination.

M) PASSING MINIMUM

A candidate shall be declared to have passed in the Theory / Practical / Project Work examination if the candidate secures not less than 50% of marks in the End Semester Examination and also in the aggregate of the prescribed marks. Submission of a duly certified Record Note Book is compulsory for the Practical examinations.

N) CLASSIFICATION OF SUCCESSFUL CANDIDATES

Candidates who secure not less than 75% of the aggregate marks in the whole examination shall be declared to have passed the examination in the First Class with Distinction, provided they pass all the examinations prescribed for the programme at the first appearance. Candidates, other than the above, who secure not less than 60% of the aggregate marks in the whole examination, shall be declared to have passed the examination in First Class. The remaining successful candidates shall be declared to have passed in Second Class. Candidates who pass all the examinations prescribed for the programme at the first instance and within a period of two academic years from the year of admission alone are eligible for University Ranking.

O) MAXIMUM DURATION FOR COMPLETION OF THE PROGRAMME

The maximum duration permitted for completion of the programme shall be three academic years from the date of normal commencement of the programme.

P) COMMENCEMENT OF THIS REGULATION

These Regulations shall take effect from the academic year 2026-2027, that is, for students who are admitted to the first year of the programme during the academic year 2026-2027 and thereafter.

ANNEXURE - I

PERIYAR UNIVERSITY

Name of the College:

Programme:

Name of the Student:

Register Number:

Title of the Project Work:

Address of Organization / Institution:

Name of the External Guide:

Designation:

Place:

Date: Signature of External Guide
(With seal)

Name of the Internal Guide:

Qualification:

Teaching Experience:

Place:

Date: Signature of Internal Guide

ANNEXURE - II

PROJECT DOCUMENTATION CURRICULUM FRAMEWORK

3.	**SYSTEM DESIGN**	
	3.1 Data Collection and Description	
	3.2 Data Preprocessing and Feature Engineering	
	3.3 Model / Algorithm Design and Methodology	
	3.4 Output Interface Design / Report Formats	
4.	**SYSTEM DEVELOPMENT & EVALUATION**	
	4.1 Description of Functional Modules	
	4.2 Model Training, Testing, and Evaluation Metrics	
5.	**CONCLUSION & FUTURE ENHANCEMENTS**	
	5.1 Conclusion	
	5.2 Scope for Future Enhancements	
6.	**BIBLIOGRAPHY / REFERENCES**	
	APPENDICES	
	A. Data Flow Diagrams / System Architecture Diagrams	
	B. Dataset Description and Field Specifications	
	C. Sample Source Code Snippets	
	D. Sample Input Screens	
	E. Sample Output Reports and Visualizations	

DEFINITIONS & LOGICAL SYLLABUS BREAKDOWN

Preliminary Pages (i to vii)

College Bonafide Certificate: Official institutional document signed by the Project Supervisor, Head of the Department (HOD), and the principal, formally certifying the originality of the research work completed by the candidate to fulfil degree regulations.

Company Attendance / Internship Certificate: Mandatory corporate document issued on official industry letterhead validating the student's external technical training execution, attendance timelines, and project module completion.

Declaration: Formal statement signed directly by the student affirming that the data science application and corresponding documentation are entirely original works and have not been submitted for any other academic degree.

Acknowledgement: Dedicated section expressing formal gratitude to the institutional administration, faculty guides, industry supervisors, and supporting individuals who provided necessary infrastructure and academic counselling.

Synopsis: Comprehensive executive summary of the technical problem statement, the dataset and tools used, the modeling approach, and definitive project outcomes.

List of Figures: Systematic index mapping every graphic element, architecture diagram, visualization, and user interface snapshot alongside the exact page allocation.

List of Tables: Structured index referencing data summaries, technical specification grids, model evaluation results, and testing logs with cross-referenced page entries.

Chapter 1: Introduction

1.1 Project Overview: High-level introduction clarifying the problem domain boundaries, intended target user audience, real-world utility, and overarching project goals.

1.2 Organization / Company Profile: Background details of the host organization or department, its field of operation, and the operational setting associated with the internship deployment.

1.3 System Specifications: The engineering constraint envelope dictating hardware capability and developer dependency environments.

1.3.1 Hardware Configuration: Infrastructure requirements including memory allocation, processor throughput, and storage subsystem requirements.

1.3.2 Software Specification: Compilation variables including operating environment, runtime platform, libraries, and frameworks used.

Chapter 2: System Analysis

2.1 Existing System Description: Documents the precise logic of current manual or legacy workflows in place before implementation.

2.2 Drawbacks and Limitations: Critical diagnosis of data quality issues, processing latency, and analytical gaps in the current approach.

2.3 Proposed System Description: Describes the proposed data science solution and how the analytical or predictive workflow is modernized and resolved through structured data-driven methods.

2.4 Core Features & System Advantages: Tabulates functional improvements such as improved accuracy, automated insights, and faster reporting.

Chapter 3: System Design

3.1 Data Collection and Description: Defines the data sources, collection methods, and dataset characteristics used in the project.

3.2 Data Preprocessing and Feature Engineering: Lays out cleaning steps, transformation logic, and feature engineering choices applied to the dataset.

3.3 Model / Algorithm Design and Methodology: Defines the modeling approach, algorithm selection rationale, and overall analytical pipeline design.

3.4 Output Interface Design / Report Formats: Lays out presentation layers, dashboards, downloadable document structures, and reporting formats.

Chapter 4: System Development & Evaluation

4.1 Description of Functional Modules: Breaks down the project into distinct operational units, showing each module's pipeline.

4.2 Model Training, Testing, and Evaluation Metrics: Establishes the model training and validation strategy, covering performance metrics, cross-validation, and result interpretation.

Chapter 5: Conclusion & Future Enhancements

5.1 Conclusion: Evaluates whether the project's objectives, as defined during the initial analysis phase, were successfully achieved.

5.2 Scope for Future Enhancements: Identifies potential extensions, such as further automation, model improvement, or scaling to larger datasets.

Chapter 6: Bibliography / References

Bibliography: An indexed list of textbooks, research papers, academic manuals, and online documentation, cited in a consistent reference style.

Appendices

A. Data Flow Diagrams / System Architecture Diagrams: Full-page diagrams charting the data pipeline, system architecture, or model workflow.

B. Dataset Description and Field Specifications: Dictionaries detailing field boundaries, data types, default values, and dataset structure.

C. Sample Source Code Snippets: Highlights of key data processing routines, core algorithms, or model implementation code.

D. Sample Input Screens: Screen captures showing filled UI entry views during standard system interactions.

E. Sample Output Reports and Visualizations: Visual reporting logs showing generated summaries, dashboards, and model output visualizations.

Subsections may be selectively adapted, omitted, or substituted with the guide's prior approval if a particular structural phase is not technically relevant to the core data science project architecture.

ANNEXURE - III

A. Format of the Title Page

TITLE OF THE PROJECT WORK

A Project Work submitted in partial fulfilment of the requirements for the degree of

Master of Science in Data Science

to the

Periyar University, Salem – 636 011

Submitted by

Name of the Student

Reg. No.

Under the Guidance of

Name of the Guide

(Designation, Name of the Department)

College

emblem

Name of the Department

College Name

(Affiliated to Periyar University)

Place with Pin Code

Month – Year

B. Format of the Certificate

College Name

(Affiliated to Periyar University)

Place with Pin Code

College

emblem

This is to certify that the Project Work entitled **Title of the Project** submitted in partial fulfilment of the requirements of the degree of **Master of Science in Data Science** to the Periyar University, Salem is a record of Bonafide work carried out by **Name of the Student**, **Reg. No.** _____ under my supervision and guidance.

Head of the Department Internal Guide

Submitted for Viva-Voce Examination held on _____ at

Name of the College, Place with Pin Code.

External Examiner Internal Examiner

SEMESTER – I
CORE – I - DATABASE SYSTEMS AND DATA WAREHOUSING

Course Objectives:

The main objectives of this course are to:

1. Understand the architecture, models, and design principles of relational database systems.
2. Design and write structured queries, joins, and procedural database programs.
3. Apply normalization techniques and understand transaction management and concurrency control.
4. Understand data warehouse architecture, dimensional modeling, and OLAP concepts.
5. Design and implement ETL pipelines and understand data warehouse optimization techniques.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Explain relational database architecture, ER modeling, and data independence concepts.	K1, K2
2	Construct complex SQL queries, joins, subqueries, triggers, and stored procedures.	K2, K3
3	Apply normalization rules up to BCNF/4NF and manage transactions using ACID properties.	K3, K4
4	Design star and snowflake schemas and build OLAP cubes for analytical reporting.	K4, K5
5	Develop ETL pipelines and optimize data warehouse queries using indexing and materialized views.	K5, K6

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

Unit:1	**Relational Database Fundamentals**	**15 hours**

Database System Architecture and Components - Entity-Relationship (ER) Modeling - Enhanced ER (EER) Concepts - Relational Model and Relational Algebra - Keys and Integrity Constraints - Three-Schema Architecture and Data Independence.

Unit:2	**SQL and Database Programming**	**15 hours**

Data Definition and Data Manipulation Language - Joins (Inner, Outer, Self) and Set Operations - Nested and Correlated Subqueries - Views and Indexes - Triggers and Assertions - Stored Procedures and

Functions using PL/SQL.		
Unit:3	**Normalization and Transaction Management**	**15 hours**
Functional Dependencies and Attribute Closure - Normal Forms (1NF, 2NF, 3NF, BCNF) - Multivalued Dependencies and 4NF - Transaction Properties (ACID) - Concurrency Control (Locking, Timestamp Ordering) - Recovery Techniques.		
Unit:4	**Data Warehouse Architecture and Modeling**	**15 hours**
Data Warehouse vs Operational Database - Data Warehouse Architecture (Single-tier, Two-tier, Three-tier) - Dimensional Modeling - Star Schema and Snowflake Schema - Fact Tables and Dimension Tables - Online Analytical Processing (OLAP) Operations (Slice, Dice, Roll-up, Drill-down).		
Unit:5	**ETL and Data Warehouse Optimization**	**15 hours**
Extraction, Transformation, and Loading (ETL) Process - Data Cleaning and Data Quality - Slowly Changing Dimensions - Indexing Strategies (Bitmap, Clustered) - Materialized Views and View Maintenance - Query Optimization and Performance Tuning.		

Mapping of Course Outcomes (COs) with Program Outcomes (POs):

CO / PO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	2	1	1
CO2	3	3	2	1	2
CO3	3	3	1	2	1
CO4	3	3	2	1	2
CO5	3	3	2	1	1

Mapping Scale: 3 = Strong / High; 2 = Moderate / Medium; 1 = Substantial / Low.

Mapping of Course Outcomes (COs) with Program Specific Outcomes (PSOs):

CO / PSO	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	1
CO2	3	2	2	1

CO3	2	2	2	1
CO4	3	3	2	1
CO5	3	3	2	2

Mapping Scale: 3 = Strong / High; 2 = Moderate / Medium; 1 = Substantial / Low.

Text Books:

- Abraham Silberschatz, Henry F. Korth, S. Sudarshan, 'Database System Concepts', 7th Ed., McGraw-Hill, 2019. (Covers Units: I - III) https://books.google.com/books?q=Database+System+Concepts+Abraham+Silberschatz%2C+Henry+F.+Korth%2C+S.+Sudarshan
- Ralph Kimball, Margy Ross, 'The Data Warehouse Toolkit: The Definitive Guide to Dimensional Modeling', 3rd Ed., Wiley, 2013. (Covers Units: IV - V) https://books.google.com/books?q=The+Data+Warehouse+Toolkit%3A+The+Definitive+Guide+to+Dimensional+Modeling+Ralph+Kimball%2C+Margy+Ross

Reference Books:

- Ramez Elmasri, Shamkant B. Navathe, 'Fundamentals of Database Systems', 7th Ed., Pearson, 2016. https://books.google.com/books?q=Fundamentals+of+Database+Systems+Ramez+Elmasri%2C+Shamkant+B.+Navathe
- Paulraj Ponniah, 'Data Warehousing Fundamentals for IT Professionals', 2nd Ed., Wiley, 2010. https://books.google.com/books?q=Data+Warehousing+Fundamentals+for+IT+Professionals+Paulraj+Ponniah

Free Online Study Resources:

- NPTEL - Database Management System (IIT Kharagpur), free video lectures with downloadable PDF notes (Free) - https://nptel.ac.in/courses/106105175
- Stanford Online - Databases (Self-Paced), free course materials and exercises (Free) - https://www.edx.org/learn/databases/stanford-university-databases

SEMESTER – I
CORE – II - STATISTICAL MACHINE LEARNING

Course Objectives:

The main objectives of this course are to:

1. Understand probability distributions, estimation methods, and the bias-variance trade-off.
2. Apply linear and regularized regression models to predictive problems.
3. Design classification models including logistic regression, SVM, and decision trees.
4. Build ensemble learning models such as bagging, random forests, and boosting.
5. Apply unsupervised learning techniques for clustering and dimensionality reduction.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Explain probability distributions, maximum likelihood estimation, and the bias-variance trade-off.	K1, K2
2	Build and evaluate linear, Ridge, and Lasso regression models.	K2, K3
3	Design classification models using logistic regression, SVM, and decision trees.	K3, K4
4	Construct ensemble models using bagging, random forests, and gradient boosting.	K4, K5
5	Apply clustering and dimensionality reduction techniques to high-dimensional datasets.	K5, K6

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

Unit:1	**Foundations of Statistical Learning**	**15 hours**

Probability Distributions (Normal, Binomial, Poisson) - Random Variables and Expectation - Maximum Likelihood Estimation - Bias-Variance Trade-off - Overfitting and Underfitting - Train-Test Split and Cross-Validation.

Unit:2	**Regression Models**	**15 hours**

Simple and Multiple Linear Regression - Ordinary Least Squares Estimation - Gradient Descent Optimization - Ridge Regression (L2 Regularization) - Lasso Regression (L1 Regularization) - Elastic

Net and Model Evaluation Metrics (RMSE, R^2).		
Unit:3	**Classification Models**	**15 hours**
Logistic Regression and the Sigmoid Function - Binary and Multi-Class Classification - Support Vector Machines and the Maximum Margin Classifier - Kernel Functions (Linear, Polynomial, RBF) - Decision Trees: Information Gain and Gini Index - Confusion Matrix, Precision, Recall, and F1-Score.		
Unit:4	**Ensemble Learning**	**15 hours**
Bootstrap Aggregation (Bagging) - Random Forests and Feature Importance - AdaBoost and Sequential Boosting - Gradient Boosting and XGBoost Basics - Hyperparameter Tuning (Grid Search, Random Search) - ROC Curve and AUC Score.		
Unit:5	**Unsupervised Learning**	**15 hours**
K-Means Clustering and the Elbow Method - Hierarchical Clustering and Dendrograms - DBSCAN Density-Based Clustering - Principal Component Analysis (PCA) - Linear Discriminant Analysis (LDA) - t-SNE for Visualization.		

Mapping of Course Outcomes (COs) with Program Outcomes (POs):

CO / PO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	1	1	2
CO2	3	3	2	1	1
CO3	3	3	2	1	1
CO4	3	3	2	1	2
CO5	3	3	1	1	2

Mapping Scale: 3 = Strong / High; 2 = Moderate / Medium; 1 = Substantial / Low.

Mapping of Course Outcomes (COs) with Program Specific Outcomes (PSOs):

CO / PSO	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	1
CO2	3	2	2	1

CO3	3	2	2	1
CO4	3	3	2	1
CO5	2	2	3	1

Mapping Scale: 3 = Strong / High; 2 = Moderate / Medium; 1 = Substantial / Low.

Text Books:

- Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, 'An Introduction to Statistical Learning, with Applications in R / Python', 2nd Ed., Springer, 2023. (Covers Units: I - V) https://books.google.com/books?q=An+Introduction+to+Statistical+Learning%2C+with+Applications+in+R+%2F+Python+Gareth+James%2C+Daniela+Witten%2C+Trevor+Hastie%2C+Robert+Tibshirani
- Aurélien Géron, 'Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow', 3rd Ed., O'Reilly Media, 2022. (Covers Units: II - V) https://books.google.com/books?q=Hands-On+Machine+Learning+with+Scikit-Learn%2C+Keras%2C+and+TensorFlow+Aur%C3%A9lien+G%C3%A9ron

Reference Books:

- Trevor Hastie, Robert Tibshirani, Jerome Friedman, 'The Elements of Statistical Learning', 2nd Ed., Springer, 2009. https://books.google.com/books?q=The+Elements+of+Statistical+Learning+Trevor+Hastie%2C+Robert+Tibshirani%2C+Jerome+Friedman
- Christopher M. Bishop, 'Pattern Recognition and Machine Learning', Springer, 2006. https://books.google.com/books?q=Pattern+Recognition+and+Machine+Learning+Christopher+M.+Bishop
- Larry Wasserman, 'All of Statistics: A Concise Course in Statistical Inference', Springer, 2004. https://books.google.com/books?q=All+of+Statistics%3A+A+Concise+Course+in+Statistical+Inference+Larry+Wasserman

Free Online Study Resources:

- An Introduction to Statistical Learning, free official PDF by the authors (Free) - https://www.statlearning.com/
- NPTEL - Introduction to Machine Learning (IIT Madras), free video lectures with downloadable PDF notes (Free) - https://nptel.ac.in/courses/106106139

SEMESTER – I

ELECTIVE – I - INFORMATION RETRIEVAL AND WEB SEARCH ENGINES

Course Objectives:

The main objectives of this course are to:

1. Understand the architecture of information retrieval systems and indexing techniques.
2. Apply term weighting and vector space models for document ranking.
3. Evaluate retrieval system performance using standard metrics.
4. Understand web crawling and link analysis algorithms.
5. Apply text classification and clustering techniques for search applications.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Explain information retrieval system architecture and construct inverted indexes.	K1, K2
2	Apply TF-IDF weighting and the vector space model to rank documents by relevance.	K2, K3
3	Evaluate retrieval systems using precision, recall, and other standard metrics.	K3, K4
4	Design web crawlers and apply PageRank and HITS algorithms for link analysis.	K4, K5
5	Build text classification and clustering systems to organize and filter search results.	K5, K6

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

Unit: 1	**Introduction to Information Retrieval**	**12 hours**

Information Retrieval System Architecture - Boolean Retrieval Model - Inverted Index Construction - Tokenization and Text Normalization - Stemming and Lemmatization - Stop Word Removal.

Unit: 2	**Term Weighting and Ranking**	**12 hours**

Term Frequency and Document Frequency - TF-IDF Weighting Scheme - Vector Space Model - Cosine Similarity for Document Ranking - Probabilistic Retrieval Models - Language Models for Information

Retrieval.		
Unit: 3	**Evaluation of Retrieval Systems**	**12 hours**
Precision, Recall, and F-Measure - Mean Average Precision (MAP) - Normalized Discounted Cumulative Gain (NDCG) - Relevance Feedback - Rocchio Algorithm - Query Expansion Techniques.		
Unit: 4	**Web Crawling and Link Analysis**	**12 hours**
Web Crawler Architecture and Politeness Policies - Robots.txt and Crawl Scheduling - Duplicate and Near-Duplicate Detection - PageRank Algorithm - Hyperlink-Induced Topic Search (HITS) - Focused Crawling.		
Unit: 5	**Text Classification and Search Applications**	**12 hours**
Naive Bayes Text Classification - Support Vector Machines for Text Categorization - Document Clustering (K-Means, Hierarchical) - XML and Semi-Structured Document Retrieval - Introduction to Semantic Search - Search Engine Monetization Basics (Sponsored Search).		

Mapping of Course Outcomes (COs) with Program Outcomes (POs):

CO / PO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	2	1	1
CO2	3	3	2	1	2
CO3	3	3	1	1	1
CO4	3	3	2	1	2
CO5	3	3	2	2	1

Mapping Scale: 3 = Strong / High; 2 = Moderate / Medium; 1 = Substantial / Low.

Mapping of Course Outcomes (COs) with Program Specific Outcomes (PSOs):

CO / PSO	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	1
CO2	3	2	2	1

CO3	2	2	3	1
CO4	3	3	2	1
CO5	2	3	2	2

Mapping Scale: 3 = Strong / High; 2 = Moderate / Medium; 1 = Substantial / Low.

Text Books:

- Christopher D. Manning, Prabhakar Raghavan, Hinrich Schütze, 'Introduction to Information Retrieval', Cambridge University Press, 2008. (Covers Units: I - V) https://books.google.com/books?q=Introduction+to+Information+Retrieval+Christopher+D.+Manning%2C+Prabhakar+Raghavan%2C+Hinrich+Sch%C3%BCtze
- W. Bruce Croft, Donald Metzler, Trevor Strohman, 'Search Engines: Information Retrieval in Practice', Pearson, 2009. (Covers Units: I - V) https://books.google.com/books?q=Search+Engines%3A+Information+Retrieval+in+Practice+W.+Bruce+Croft%2C+Donald+Metzler%2C+Trevor+Strohman

Reference Books:

- Ricardo Baeza-Yates, Berthier Ribeiro-Neto, 'Modern Information Retrieval: The Concepts and Technology behind Search', 2nd Ed., ACM Press, 2011. https://books.google.com/books?q=Modern+Information+Retrieval%3A+The+Concepts+and+Technology+behind+Search+Ricardo+Baeza-Yates%2C+Berthier+Ribeiro-Neto
- Jure Leskovec, Anand Rajaraman, Jeffrey D. Ullman, 'Mining of Massive Datasets', 3rd Ed., Cambridge University Press, 2020. https://books.google.com/books?q=Mining+of+Massive+Datasets+Jure+Leskovec%2C+Anand+Rajaraman%2C+Jeffrey+D.+Ullman

Free Online Study Resources:

- Introduction to Information Retrieval, free official online textbook by Manning, Raghavan, Schütze (Free) - https://nlp.stanford.edu/IR-book/information-retrieval-book.html
- NPTEL - Information Retrieval (IIT Kharagpur), free video lectures with downloadable PDF notes (Free) - https://nptel.ac.in/courses/106105254

SEMESTER – I
ELECTIVE – I (OPTION) - SOCIAL NETWORK ANALYSIS AND GRAPH DATABASES

Course Objectives:

The main objectives of this course are to:

1. Understand graph theory fundamentals and network representation models.
2. Apply centrality measures to identify influential nodes in a network.
3. Detect communities in networks using modern clustering algorithms.
4. Understand graph database concepts and query graph data using Cypher.
5. Apply graph algorithms and graph neural networks to real-world network problems.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Explain graph theory concepts and represent networks using adjacency structures.	K1, K2
2	Compute centrality measures to identify important nodes in a social network.	K2, K3
3	Apply community detection algorithms to partition networks into meaningful clusters.	K3, K4
4	Design property graph schemas and write Cypher queries for graph databases.	K4, K5
5	Build graph-based applications using traversal algorithms and graph neural networks.	K5, K6

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

Unit:1	**Graph Theory Fundamentals**	**12 hours**

Graph Representation (Adjacency Matrix and List) - Directed and Undirected Graphs - Paths, Walks, and Cycles - Connected Components - Bipartite Graphs - Network Data Collection and Visualization Tools.

Unit:2	**Centrality and Network Properties**	**12 hours**

Degree Centrality - Betweenness Centrality - Closeness Centrality - Eigenvector Centrality and PageRank

- Power-Law Degree Distributions - Small-World Networks and Clustering Coefficients.		
Unit:3	**Community Detection**	**12 hours**
Cliques and Subgraphs - Modularity and Modularity Maximization - Girvan-Newman Algorithm - Louvain Method for Community Detection - Spectral Clustering on Graphs - Label Propagation Algorithm.		
Unit:4	**Graph Databases**	**12 hours**
Relational vs Graph Data Models - Property Graph Model - Introduction to Neo4j - Cypher Query Language Basics - Pattern Matching Queries - Graph Database Indexing.		
Unit:5	**Graph Algorithms and Applications**	**12 hours**
Shortest Path Algorithms (Breadth-First Search, Dijkstra) - Connected Components in Neo4j - Introduction to Graph Neural Networks - Graph Convolutional Networks (Conceptual Overview) - Applications in Recommendation Systems - Fraud Detection Using Graph Analytics.		

Mapping of Course Outcomes (COs) with Program Outcomes (POs):

CO / PO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	1	1	1
CO2	3	3	1	1	2
CO3	3	3	2	1	2
CO4	3	3	3	1	1
CO5	3	3	2	1	2

Mapping Scale: 3 = Strong / High; 2 = Moderate / Medium; 1 = Substantial / Low.

Mapping of Course Outcomes (COs) with Program Specific Outcomes (PSOs):

CO / PSO	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	1
CO2	2	3	1	1
CO3	3	2	2	1

CO4	3	2	3	1
CO5	3	3	2	2

Mapping Scale: 3 = Strong / High; 2 = Moderate / Medium; 1 = Substantial / Low.

Text Books:

- David Easley, Jon Kleinberg, 'Networks, Crowds, and Markets: Reasoning About a Highly Connected World', Cambridge University Press, 2010. (Covers Units: I - III) https://books.google.com/books?q=Networks%2C+Crowds%2C+and+Markets%3A+Reasoning+About+a+Highly+Connected+World+David+Easley%2C+Jon+Kleinberg
- Ian Robinson, Jim Webber, Emil Eifrem, 'Graph Databases', 2nd Ed., O'Reilly Media, 2015. (Covers Units: IV - V) https://books.google.com/books?q=Graph+Databases+Ian+Robinson%2C+Jim+Webber%2C+Emil+Eifrem

Reference Books:

- Albert-László Barabási, 'Network Science', Cambridge University Press, 2016. https://books.google.com/books?q=Network+Science+Albert-L%C3%A1szl%C3%B3+Barab%C3%A1si
- Mark Needham, Amy E. Hodler, 'Graph Algorithms: Practical Examples in Apache Spark and Neo4j', 1st Ed., O'Reilly Media, 2019. https://books.google.com/books?q=Graph+Algorithms%3A+Practical+Examples+in+Apache+Spark+and+Neo4j+Mark+Needham%2C+Amy+E.+Hodler

Free Online Study Resources:

- Networks, Crowds, and Markets, free official online version by the authors (Free) - https://www.cs.cornell.edu/home/kleinber/networks-book/
- Network Science by Albert-László Barabási, free official online textbook (Free) - http://networksciencebook.com/

SEMESTER – I
PRACTICAL – I - DATABASE SYSTEMS AND DATA WAREHOUSING LAB

Learning Objective (LO):

To provide hands-on practice in relational database design, SQL query writing, and dimensional data warehouse modeling.

List of Programs:

01. Create database tables using Data Definition Language (DDL) statements with appropriate primary key, foreign key, and check constraints.
02. Perform Data Manipulation Language (DML) operations: insert, update, delete, and retrieve records using SELECT queries.
03. Write SQL queries using inner joins, outer joins, and self-joins across multiple related tables.
04. Write nested and correlated subqueries to solve multi-step data retrieval problems.
05. Create and test database triggers to enforce automatic validation rules on table updates.
06. Develop stored procedures and user-defined functions using PL/SQL for common business logic.
07. Design a star schema for a sample business scenario, identifying fact and dimension tables.
08. Design a snowflake schema by normalizing dimension tables from a given star schema.
09. Build a simple ETL script to extract data from a source table, transform it, and load it into a target table.
10. Create and refresh a materialized view, and compare its query performance against a regular view.

Expected Course Outcomes:

On the successful completion of this practical course, student will be able to:

1	CO1: Create relational tables with appropriate constraints and perform core DML operations.	K1, K2
2	CO2: Construct multi-table joins and nested subqueries to retrieve complex result sets.	K2, K3
3	CO3: Implement triggers, stored procedures, and functions to enforce business logic in the database.	K3, K4
4	CO4: Design star and snowflake schemas for dimensional data warehouse modeling.	K4, K5

5	CO5: Build ETL scripts and materialized views to support analytical reporting workflows.	K5, K6
K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create		

Mapping of Course Outcomes (COs) with Program Outcomes (POs):

CO / PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	3	2	1	1
CO2	3	3	2	1	2
CO3	3	3	1	2	1
CO4	3	3	2	1	2
CO5	3	3	2	1	1

Mapping Scale: 3 = Strong / High; 2 = Moderate / Medium; 1 = Substantial / Low.

Mapping of Course Outcomes (COs) with Program Specific Outcomes (PSOs):

CO / PSO	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	2	2	1
CO2	3	2	2	1
CO3	2	2	2	1
CO4	3	3	2	1
CO5	3	3	2	2

Mapping Scale: 3 = Strong / High; 2 = Moderate / Medium; 1 = Substantial / Low.

SEMESTER – I
PRACTICAL – II - STATISTICAL MACHINE LEARNING LAB

Learning Objective (LO):

To provide hands-on practice in building, training, and evaluating supervised and unsupervised machine learning models using Python.

List of Programs:

01. Implement Simple and Multiple Linear Regression on a dataset and evaluate using RMSE and R^2 score.
02. Implement Ridge and Lasso Regression and compare their coefficients against ordinary linear regression.
03. Implement Logistic Regression for binary classification and evaluate using a confusion matrix.
04. Implement a Support Vector Machine classifier with linear and RBF kernels and compare decision boundaries.
05. Build a Decision Tree classifier and visualize the tree, identifying the most important splitting features.
06. Implement Random Forest classification and compare its accuracy with a single decision tree.
07. Implement AdaBoost or Gradient Boosting on a classification dataset and tune key hyperparameters.
08. Implement K-Means clustering and determine the optimal number of clusters using the elbow method.
09. Implement Hierarchical Agglomerative Clustering and visualize the result using a dendrogram.
10. Apply Principal Component Analysis (PCA) to reduce dimensionality and visualize the result in 2D.

Expected Course Outcomes:

On the successful completion of this practical course, student will be able to:

1	CO1: Build and evaluate linear, Ridge, and Lasso regression models on a sample dataset.	K1, K2
2	CO2: Construct logistic regression and SVM classifiers and evaluate them using a confusion matrix.	K2, K3
3	CO3: Build decision tree, random forest, and boosting models and compare	K3, K4

	their performance.	
4	CO4: Implement K-Means and hierarchical clustering and determine appropriate cluster counts.	K4, K5
5	CO5: Apply PCA for dimensionality reduction and interpret the resulting feature space.	K5, K6
K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create		

Mapping of Course Outcomes (COs) with Program Outcomes (POs):

CO / PO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	1	1	2
CO2	3	3	2	1	1
CO3	3	3	2	1	1
CO4	3	3	2	1	2
CO5	3	3	1	1	2

Mapping Scale: 3 = Strong / High; 2 = Moderate / Medium; 1 = Substantial / Low.

Mapping of Course Outcomes (COs) with Program Specific Outcomes (PSOs):

CO / PSO	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	1
CO2	3	2	2	1
CO3	3	2	2	1
CO4	3	3	2	1
CO5	2	2	3	1

Mapping Scale: 3 = Strong / High; 2 = Moderate / Medium; 1 = Substantial / Low.

SEMESTER – I
SEC – I - CYBER SECURITY AND DATA PRIVACY

Course Objectives:

The main objectives of this course are to:

1. Understand fundamental cyber security concepts and common attack vectors.
2. Learn cryptographic techniques for securing data in transit and at rest.
3. Understand network defense mechanisms and secure development practices.
4. Learn key data privacy regulations applicable to data science practice.
5. Understand privacy-preserving techniques for handling sensitive data.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Explain core security principles (CIA Triad) and identify common attack vectors.	K1, K2
2	Apply symmetric and asymmetric cryptographic techniques to secure data.	K2, K3
3	Apply network defense tools (firewalls, IDS) and secure coding practices.	K3, K4
4	Evaluate data handling practices against GDPR, DPDP Act, and other privacy regulations.	K4, K5
5	Apply anonymization and differential privacy techniques to protect sensitive datasets.	K5, K6

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

Unit: 1	**Foundations of Cyber Security**	**6 hours**

CIA Triad (Confidentiality, Integrity, Availability) - Common Threats: Malware, Phishing, Social Engineering - Vulnerabilities and Exploits - Security Policies and Risk Assessment - Incident Response Basics.

Unit: 2	**Cryptography Essentials**	**6 hours**

Symmetric Key Cryptography (AES) - Asymmetric Key Cryptography (RSA) - Hash Functions (SHA-256) - Digital Signatures - Public Key Infrastructure (PKI) - Secure Socket Layer / Transport Layer

Security (SSL/TLS) Basics.		
Unit: 3	**Network and Application Security**	**6 hours**
Firewalls and Packet Filtering - Intrusion Detection and Prevention Systems - Virtual Private Networks (VPN) - Secure Software Development Lifecycle - Common Vulnerability Scoring System (CVSS) - Basics of Penetration Testing.		
Unit: 4	**Data Privacy Regulations**	**6 hours**
Personally Identifiable Information (PII) - General Data Protection Regulation (GDPR) Overview - Digital Personal Data Protection (DPDP) Act, India - Data Protection Officer Role - Consent Management - Cross-Border Data Transfer Rules.		
Unit: 5	**Privacy-Preserving Techniques**	**6 hours**
Data Anonymization and Pseudonymization - k-Anonymity and l-Diversity - Differential Privacy Concepts - Homomorphic Encryption (Conceptual Overview) - Secure Multi-Party Computation (Conceptual Overview) - Privacy by Design Principles.		

Mapping of Course Outcomes (COs) with Program Outcomes (POs):

CO / PO	PO1	PO2	PO3	PO4	PO5
CO1	2	2	1	3	1
CO2	1	2	2	3	2
CO3	2	1	2	3	1
CO4	1	1	1	3	2
CO5	2	2	2	3	2

Mapping Scale: 3 = Strong / High; 2 = Moderate / Medium; 1 = Substantial / Low.

Mapping of Course Outcomes (COs) with Program Specific Outcomes (PSOs):

CO / PSO	PSO1	PSO2	PSO3	PSO4
CO1	1	1	1	3

CO2	1	2	1	3
CO3	2	1	2	3
CO4	1	1	1	3
CO5	2	2	2	3

Mapping Scale: 3 = Strong / High; 2 = Moderate / Medium; 1 = Substantial / Low.

Text Books:

- William Stallings, 'Cryptography and Network Security: Principles and Practice', 8th Ed., Pearson, 2020. (Covers Units: I - III) https://books.google.com/books?q=Cryptography+and+Network+Security%3A+Principles+and+Practice+William+Stallings
- Jaap-Henk Hoepman, 'Privacy Is Hard and Seven Other Myths: Achieving Privacy through Careful Design', MIT Press, 2021. (Covers Units: IV - V) https://books.google.com/books?q=Privacy+Is+Hard+and+Seven+Other+Myths%3A+Achieving+Privacy+through+Careful+Design+Jaap-Henk+Hoepman

Reference Books:

- Nina Godbole, Sunit Belapure, 'Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives', Wiley India, 2011. https://books.google.com/books?q=Cyber+Security%3A+Understanding+Cyber+Crimes%2C+Computer+Forensics+and+Legal+Perspectives+Nina+Godbole%2C+Sunit+Belapure
- Cynthia Dwork, Aaron Roth, 'The Algorithmic Foundations of Differential Privacy', NOW Publishers, 2014. https://books.google.com/books?q=The+Algorithmic+Foundations+of+Differential+Privacy+Cynthia+Dwork%2C+Aaron+Roth

Free Online Study Resources:

- NPTEL - Cyber Security (IIT Kharagpur / IIT Madras), free video lectures with downloadable PDF notes (Free) - https://nptel.ac.in/courses/106106129
- Ministry of Electronics and IT, Government of India - Digital Personal Data Protection Act 2023, official free text (Free) - https://www.meity.gov.in/data-protection-framework

SEMESTER – II
CORE – III - PYTHON PROGRAMMING FOR DATA SCIENCE

Course Objectives:

The main objectives of this course are to:

1. Understand core Python data types, control structures, and functions.
2. Apply object-oriented programming concepts to build modular Python programs.
3. Use NumPy for efficient numerical and array-based computation.
4. Use Pandas for data manipulation, cleaning, and exploratory analysis.
5. Apply Python tools for working with time-series data and large files.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Write Python programs using core data types, control flow, and functions.	K1, K2
2	Design object-oriented Python programs using classes, inheritance, and exception handling.	K2, K3
3	Perform vectorized numerical computations using NumPy arrays.	K3, K4
4	Clean, transform, and analyze structured data using Pandas DataFrames.	K4, K5
5	Process time-series data and large datasets efficiently using Python tools.	K5, K6

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

Unit:1	**Python Programming Fundamentals**	**15 hours**

Data Types and Variables - Control Flow (Conditionals, Loops) - Functions and Default Arguments - Lists, Tuples, Sets, and Dictionaries - List Comprehensions - File Handling Basics.

Unit:2	**Object-Oriented Programming in Python**	**15 hours**

Classes and Objects - Inheritance and Polymorphism - Encapsulation and Access Modifiers - Special (Dunder) Methods - Custom Exception Handling - Context Managers and the with Statement.

Unit:3	**NumPy for Numerical Computing**	**15 hours**

N-Dimensional Arrays (ndarray) - Array Creation and Indexing - Broadcasting Rules - Vectorized

Operations and Universal Functions - Basic Linear Algebra Operations - Random Number Generation.		
Unit:4	**Data Analysis with Pandas**	**15 hours**
Series and DataFrame Structures - Data Selection, Filtering, and Indexing - Handling Missing Data - GroupBy: Split-Apply-Combine - Merging, Joining, and Concatenating DataFrames - Pivot Tables and Reshaping Data.		
Unit:5	**Working with Time-Series and Large Data**	**15 hours**
Datetime Indexing and Resampling - Rolling and Window Functions - Reading and Writing CSV, JSON, and Parquet Files - Connecting Python to Relational Databases - Basics of Multiprocessing in Python - Introduction to the Global Interpreter Lock (GIL).		

Mapping of Course Outcomes (COs) with Program Outcomes (POs):

CO / PO	PO1	PO2	PO3	PO4	PO5
CO1	2	2	3	1	2
CO2	1	2	3	1	1
CO3	2	2	3	1	1
CO4	2	1	3	1	2
CO5	2	2	3	1	2

Mapping Scale: 3 = Strong / High; 2 = Moderate / Medium; 1 = Substantial / Low.

Mapping of Course Outcomes (COs) with Program Specific Outcomes (PSOs):

CO / PSO	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	1
CO2	3	2	2	1
CO3	3	2	2	1
CO4	3	3	2	1
CO5	2	3	2	1

Mapping Scale: 3 = Strong / High; 2 = Moderate / Medium; 1 = Substantial / Low.

Text Books:

- Jake VanderPlas, 'Python Data Science Handbook: Essential Tools for Working with Data', 2nd Ed., O'Reilly Media, 2022. (Covers Units: I, III, IV, V) https://books.google.com/books?q=Python+Data+Science+Handbook%3A+Essential+Tools+for+Working+with+Data+Jake+VanderPlas
- Wes McKinney, 'Python for Data Analysis: Data Wrangling with pandas, NumPy, and Jupyter', 3rd Ed., O'Reilly Media, 2022. (Covers Units: III, IV, V) https://wesmckinney.com/book/

Reference Books:

- Mark Lutz, 'Learning Python', 5th Ed., O'Reilly Media, 2013. https://books.google.com/books?q=Learning+Python+Mark+Lutz
- Eric Matthes, 'Python Crash Course: A Hands-On, Project-Based Introduction to Programming', 3rd Ed., No Starch Press, 2023. https://books.google.com/books?q=Python+Crash+Course%3A+A+Hands-On%2C+Project-Based+Introduction+to+Programming+Eric+Matthes

Free Online Study Resources:

- Python Data Science Handbook, free official online edition by Jake VanderPlas (Free) - https://jakevdp.github.io/PythonDataScienceHandbook/
- Python for Data Analysis, free official online edition by Wes McKinney (Free) - https://wesmckinney.com/book/

SEMESTER – II
CORE – IV - DEEP LEARNING AND GENERATIVE AI

Course Objectives:

The main objectives of this course are to:

1. Understand the fundamentals of neural networks and the backpropagation algorithm.
2. Design convolutional neural networks for image classification and object detection.
3. Design recurrent and attention-based networks for sequence modeling.
4. Understand transformer architecture and its applications.
5. Understand generative models and apply retrieval-augmented generation techniques.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Explain neural network fundamentals and apply backpropagation for model training.	K1, K2
2	Design convolutional neural networks for image classification tasks.	K2, K3
3	Apply recurrent networks (LSTM, GRU) and attention mechanisms to sequence data.	K3, K4
4	Build transformer-based models for natural language and vision tasks.	K4, K5
5	Design generative models and retrieval-augmented generation pipelines for real-world applications.	K5, K6

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

Unit:1	**Foundations of Neural Networks**	**15 hours**

The Perceptron and Multi-Layer Perceptron - Activation Functions (ReLU, Sigmoid, Softmax) - Forward Propagation - Loss Functions - Backpropagation Algorithm - Gradient Descent Variants (SGD, Adam, RMSprop).

Unit:2	**Convolutional Neural Networks**	**15 hours**

Convolution and Pooling Operations - CNN Architectures (LeNet, VGG Concepts) - Padding and Stride - Batch Normalization and Dropout - Transfer Learning with Pretrained Models - Introduction to Object

Detection (YOLO Overview).		
Unit:3	**Recurrent Networks and Sequence Modeling**	**15 hours**
Recurrent Neural Networks (RNN) - The Vanishing and Exploding Gradient Problem - Long Short-Term Memory (LSTM) Networks - Gated Recurrent Units (GRU) - Sequence-to-Sequence Models - Introduction to Attention Mechanisms.		
Unit:4	**Transformer Architecture**	**15 hours**
Self-Attention and Scaled Dot-Product Attention - Multi-Head Attention - Positional Encoding - Transformer Encoder-Decoder Structure - Vision Transformers (ViT) Overview - Pretrained Transformer Models (BERT, GPT Family Overview).		
Unit:5	**Generative Models and Applications**	**15 hours**
Autoencoders and Variational Autoencoders (VAE) - Generative Adversarial Networks (GANs) - Introduction to Diffusion Models - Large Language Model Basics and Prompting - Retrieval-Augmented Generation (RAG) Pipelines - Responsible and Ethical Use of Generative AI.		

Mapping of Course Outcomes (COs) with Program Outcomes (POs):

CO / PO	PO1	PO2	PO3	PO4	PO5
CO1	2	2	1	1	3
CO2	2	2	2	1	3
CO3	2	1	2	2	3
CO4	1	2	2	1	3
CO5	2	2	2	2	3

Mapping Scale: 3 = Strong / High; 2 = Moderate / Medium; 1 = Substantial / Low.

Mapping of Course Outcomes (COs) with Program Specific Outcomes (PSOs):

CO / PSO	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	3

CO2	2	2	2	3
CO3	2	2	2	3
CO4	2	2	2	3
CO5	2	2	2	3

Mapping Scale: 3 = Strong / High; 2 = Moderate / Medium; 1 = Substantial / Low.

Text Books:

- Aurélien Géron, 'Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow', 3rd Ed., O'Reilly Media, 2022. (Covers Units: I, II, III) https://books.google.com/books?q=Hands-On+Machine+Learning+with+Scikit-Learn%2C+Keras%2C+and+TensorFlow+Aur%C3%A9lien+G%C3%A9ron
- Ian Goodfellow, Yoshua Bengio, Aaron Courville, 'Deep Learning', MIT Press, 2016. (Covers Units: I, II, III, V) https://www.deeplearningbook.org/

Reference Books:

- Eli Stevens, Luca Antiga, Thomas Viehmann, 'Deep Learning with PyTorch', Manning Publications, 2020. (Covers Units: II, III, IV) https://www.deeplearningbook.org/
- Francois Chollet, 'Deep Learning with Python', 2nd Ed., Manning Publications, 2021. https://www.deeplearningbook.org/

Free Online Study Resources:

- Deep Learning, free official online textbook by Goodfellow, Bengio, Courville (Free) - https://www.deeplearningbook.org/
- NPTEL - Deep Learning (IIT Madras / IIT Ropar), free video lectures with downloadable PDF notes (Free) - https://nptel.ac.in/courses/106106184

SEMESTER – II
ELECTIVE – II - BIOINFORMATICS, GENOMIC DATA PROCESSING, AND HEALTH INFORMATICS

Course Objectives:

The main objectives of this course are to:

1. Understand biological sequence data and standard file formats.
2. Apply sequence alignment algorithms to compare biological sequences.
3. Understand next-generation sequencing data processing pipelines.
4. Understand electronic health record standards and clinical data interoperability.
5. Understand medical imaging data and applications of AI in healthcare.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Explain DNA, RNA, and protein sequence data and parse FASTA/FASTQ files.	K1,K2
2	Apply pairwise and multiple sequence alignment algorithms to biological sequences.	K2,K3
3	Process next-generation sequencing data and interpret variant call files.	K3,K4
4	Design interoperable health data systems using HL7/FHIR and standard medical ontologies.	K4,K5
5	Apply machine learning techniques to medical imaging and predictive healthcare analytics.	K5,K6

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

Unit:1	**Introduction to Bioinformatics**	**12 hours**

DNA, RNA, and Protein Structure Basics - The Central Dogma of Molecular Biology - Biological Sequence Databases (NCBI, GenBank) - FASTA and FASTQ File Formats - Sequence Quality Scores (Phred) - Introduction to Sequence Assembly.

Unit:2	**Sequence Alignment**	**12 hours**

Dynamic Programming for Sequence Alignment - Needleman-Wunsch Global Alignment - Smith-

Waterman Local Alignment - BLAST Heuristic Search - Multiple Sequence Alignment - Introduction to Phylogenetic Trees.		
Unit:3	**Next-Generation Sequencing and Genomics**	**12 hours**
Next-Generation Sequencing (NGS) Workflow - Read Alignment Formats (SAM/BAM) - Variant Calling and the VCF Format - RNA-Seq and Gene Expression Analysis - Differential Gene Expression Basics - Genome-Wide Association Studies (GWAS) Overview.		
Unit:4	**Health Informatics**	**12 hours**
Electronic Health Records (EHR) - HL7 Messaging Standards - FHIR (Fast Healthcare Interoperability Resources) - SNOMED-CT and ICD-10 Coding Systems - Clinical Decision Support Systems - Health Data Privacy (HIPAA Overview).		
Unit:5	**Medical Imaging and AI in Healthcare**	**12 hours**
DICOM Medical Image Format - Basics of Medical Image Segmentation - Predictive Modeling for Patient Risk - AI Applications in Drug Discovery (Overview) - Federated Learning for Healthcare Data - Ethical Considerations in Health AI.		
	Total Lecture hours	**60 hours**

Mapping of Course Outcomes (COs) with Program Outcomes (POs):

CO / PO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	1	1	1
CO2	3	3	1	1	2
CO3	3	2	2	1	1
CO4	2	3	2	2	1
CO5	3	3	2	2	2

Mapping Scale: 3 = Strong / High; 2 = Moderate / Medium; 1 = Substantial / Low.

Mapping of Course Outcomes (COs) with Program Specific Outcomes (PSOs):

CO / PSO	PSO1	PSO2	PSO3	PSO4

CO1	3	3	1	1
CO2	3	3	1	2
CO3	3	2	2	1
CO4	2	3	2	1
CO5	3	3	2	2

Mapping Scale: 3 = Strong / High; 2 = Moderate / Medium; 1 = Substantial / Low.

Text Books:

- Arthur M. Lesk, 'Introduction to Bioinformatics', 5th Ed., Oxford University Press, 2019. (Covers Units: I, II, III) https://books.google.com/books?q=Introduction+to+Bioinformatics+Arthur+M.+Lesk
- Robert Hoyt, Ann Yoshihashi, 'Health Informatics: Practical Guide', 7th Ed., Informatics Education, 2018. (Covers Units: IV, V) https://books.google.com/books?q=Health+Informatics%3A+Practical+Guide+Robert+Hoyt%2C+Ann+Yoshihashi

Reference Books:

- Phillip Compeau, Pavel Pevzner, 'Bioinformatics Algorithms: An Active Learning Approach', 3rd Ed., Active Learning Publishers, 2018. https://books.google.com/books?q=Bioinformatics+Algorithms%3A+An+Active+Learning+Approach+Phillip+Compeau%2C+Pavel+Pevzner
- David W. Mount, 'Bioinformatics: Sequence and Genome Analysis', 2nd Ed., Cold Spring Harbor Laboratory Press, 2004. https://books.google.com/books?q=Bioinformatics%3A+Sequence+and+Genome+Analysis+David+W.+Mount

Free Online Study Resources:

- NCBI Bioinformatics Resources, free official tools and tutorials (Free) - https://www.ncbi.nlm.nih.gov/guide/all/
- NPTEL - Bioinformatics: Algorithms and Applications (IIT Kharagpur), free video lectures with downloadable PDF notes (Free) - https://nptel.ac.in/courses/102106065

SEMESTER – II
ELECTIVE – II (OPTION) - EDGE AI, IOT ANALYTICS, AND EMBEDDED SYSTEMS

Course Objectives:

The main objectives of this course are to:

1. Understand IoT system architecture and embedded hardware fundamentals.
2. Understand microcontroller programming and communication protocols.
3. Apply data analytics techniques to streaming sensor data.
4. Apply model compression techniques to deploy machine learning models on edge devices.
5. Understand deployment considerations for embedded machine learning systems.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Explain IoT system architecture and basic embedded hardware components.	K1, K2
2	Program microcontrollers and interface sensors using standard communication protocols.	K2, K3
3	Process and analyze streaming sensor data using basic statistical techniques.	K3, K4
4	Apply quantization and pruning techniques to compress models for edge deployment.	K4, K5
5	Deploy lightweight machine learning models on resource-constrained edge devices.	K5, K6

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

Unit:1	**IoT and Embedded Systems Fundamentals**	**12 hours**

IoT Reference Architecture - Sensors and Actuators - Microcontrollers vs Microprocessors - Edge Computing vs Cloud Computing - Analog-to-Digital Conversion Basics - Common IoT Communication Buses (I2C, SPI, UART).

Unit:2	**Microcontroller Programming**	**12 hours**

ARM Cortex-M and ESP32 Architecture Overview - Programming Microcontrollers (Arduino / MicroPython) - Real-Time Operating System Basics - Interfacing Sensors and Actuators - Power

Management for Embedded Devices - Wireless Connectivity (Wi-Fi, Bluetooth Low Energy).		
Unit:3	**IoT Data Analytics**	**12 hours**
Sensor Data Acquisition and Pre-processing - Sliding Window Techniques for Streaming Data - Basic Statistical Feature Extraction - Anomaly Detection in Sensor Streams - MQTT Protocol for IoT Messaging - Introduction to Time-Series Forecasting for IoT Data.		
Unit:4	**Model Compression for Edge Deployment**	**12 hours**
Challenges of Deploying ML Models on Edge Devices - Model Pruning Techniques - Quantization (Float to Integer Conversion) - Knowledge Distillation Basics - TensorFlow Lite for Microcontrollers - Benchmarking Model Size vs Accuracy Trade-offs.		
Unit:5	**TinyML and Deployment**	**12 hours**
Introduction to TinyML - Memory and Compute Constraints on Microcontrollers - On-Device Inference Pipelines - Case Study: Keyword Spotting and Gesture Recognition - Over-the-Air Model Updates - Security Considerations for IoT and Edge AI.		

Mapping of Course Outcomes (COs) with Program Outcomes (POs):

CO / PO	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	1	1
CO2	2	2	3	1	1
CO3	2	2	2	1	2
CO4	2	2	3	1	2
CO5	3	3	2	1	2

Mapping Scale: 3 = Strong / High; 2 = Moderate / Medium; 1 = Substantial / Low.

Mapping of Course Outcomes (COs) with Program Specific Outcomes (PSOs):

CO / PSO	PSO1	PSO2	PSO3	PSO4
CO1	2	2	3	1
CO2	2	1	3	1

CO3	2	2	2	1
CO4	2	2	3	1
CO5	3	3	2	2

Mapping Scale: 3 = Strong / High; 2 = Moderate / Medium; 1 = Substantial / Low.

Text Books:

- Pete Warden, Daniel Situnayake, 'TinyML: Machine Learning with TensorFlow Lite on Arduino and Ultra-Low-Power Microcontrollers', O'Reilly Media, 2019. (Covers Units: III, IV, V) https://books.google.com/books?q=TinyML%3A+Machine+Learning+with+TensorFlow+Lite+on+Arduino+and+Ultra-Low-Power+Microcontrollers+Pete+Warden%2C+Daniel+Situnayake
- Gian Marco Iodice, 'TinyML Cookbook', 2nd Ed., Packt Publishing, 2023. (Covers Units: IV, V) https://books.google.com/books?q=TinyML+Cookbook+Gian+Marco+Iodice

Reference Books:

- Perry Lea, 'IoT and Edge Computing for Architects', 2nd Ed., Packt Publishing, 2020. https://books.google.com/books?q=IoT+and+Edge+Computing+for+Architects+Perry+Lea
- Arshdeep Bahga, Vijay Madisetti, 'Internet of Things: A Hands-On Approach', 1st Ed., Universities Press, 2014. https://books.google.com/books?q=Internet+of+Things%3A+A+Hands-On+Approach+Arshdeep+Bahga%2C+Vijay+Madisetti

Free Online Study Resources:

- TensorFlow Lite for Microcontrollers, free official documentation (Free) - https://www.tensorflow.org/lite/microcontrollers
- NPTEL - Introduction to Internet of Things (IIT Kharagpur), free video lectures with downloadable PDF notes (Free) - https://nptel.ac.in/courses/106105166

SEMESTER – II

PRACTICAL – III - PYTHON PROGRAMMING FOR DATA SCIENCE LAB

Learning Objective (LO):

To provide hands-on practice in core Python programming, object-oriented design, and data manipulation using NumPy and Pandas.

List of Programs:

01. Write Python programs using functions with default and variable-length arguments to solve simple computational problems.
02. Design a class hierarchy demonstrating inheritance, method overriding, and polymorphism.
03. Implement encapsulation using private attributes and demonstrate the use of dunder (magic) methods.
04. Implement custom exception classes and a context manager using the with statement.
05. Perform array creation, indexing, and broadcasting operations using NumPy.
06. Perform data filtering, sorting, and pivoting operations on a dataset using Pandas DataFrames.
07. Perform merge, join, and concatenation operations across multiple Pandas DataFrames.
08. Perform time-series resampling and rolling-window calculations on a date-indexed dataset.
09. Read and write data in CSV, JSON, and Parquet file formats using Pandas.
10. Implement a simple parallel processing task using Python's multiprocessing module.

Expected Course Outcomes:

On the successful completion of this practical course, student will be able to:

1	CO1: Write Python functions and demonstrate scope resolution using variable-length arguments.	K1, K2
2	CO2: Design class hierarchies demonstrating inheritance, encapsulation, and polymorphism.	K2, K3
3	CO3: Implement custom exception handling and context managers for robust program design.	K3, K4
4	CO4: Perform vectorized array computations and advanced DataFrame	K4, K5

	transformations.	
5	CO5: Build file-handling and parallel-processing routines for efficient data workflows.	K5, K6
K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create		

Mapping of Course Outcomes (COs) with Program Outcomes (POs):

CO / PO	PO1	PO2	PO3	PO4	PO5
CO1	2	2	3	1	2
CO2	1	2	3	1	1
CO3	2	2	3	1	1
CO4	2	1	3	1	2
CO5	2	2	3	1	2

Mapping Scale: 3 = Strong / High; 2 = Moderate / Medium; 1 = Substantial / Low.

Mapping of Course Outcomes (COs) with Program Specific Outcomes (PSOs):

CO / PSO	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	1
CO2	3	2	2	1
CO3	3	2	2	1
CO4	3	3	2	1
CO5	2	3	2	1

Mapping Scale: 3 = Strong / High; 2 = Moderate / Medium; 1 = Substantial / Low.

SEMESTER – II

PRACTICAL – IV - DEEP LEARNING AND GENERATIVE AI LAB

Learning Objective (LO):

To provide hands-on practice in building, training, and evaluating neural network architectures for classification, vision, and generative tasks.

List of Programs:

01. Build and train a Multi-Layer Perceptron for a classification task using backpropagation.
02. Compare model performance using different optimizers (SGD, Adam, RMSprop) and dropout regularization.
03. Build a Convolutional Neural Network (CNN) for image classification on a standard image dataset.
04. Apply transfer learning using a pretrained CNN model for a new image classification task.
05. Build an LSTM-based model for sequence prediction on a sample text or time-series dataset.
06. Implement a basic self-attention layer and visualize the attention weights on a sample input.
07. Fine-tune a small pretrained Vision Transformer (ViT) model on a sample image dataset.
08. Build a simple Generative Adversarial Network (GAN) to generate synthetic images from a basic dataset.
09. Use a pretrained causal language model to perform text generation with different decoding strategies.
10. Build a basic Retrieval-Augmented Generation (RAG) pipeline using vector embeddings and a document store.

Expected Course Outcomes:

On the successful completion of this practical course, student will be able to:

1	CO1: Build and train a Multi-Layer Perceptron and tune optimizers and regularization settings.	K1, K2
2	CO2: Design CNN architectures and apply transfer learning for image classification tasks.	K2, K3
3	CO3: Build LSTM-based models and implement self-attention layers for sequence data.	K3, K4

4	CO4: Fine-tune transformer-based models, including Vision Transformers, for given tasks.	K4, K5
5	CO5: Build generative and retrieval-augmented generation pipelines for practical applications.	K5, K6
K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create		

Mapping of Course Outcomes (COs) with Program Outcomes (POs):

CO / PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	1	1	1	3
CO2	1	2	2	1	3
CO3	2	1	1	2	3
CO4	1	1	2	1	3
CO5	2	2	2	1	3

Mapping Scale: 3 = Strong / High; 2 = Moderate / Medium; 1 = Substantial / Low.

Mapping of Course Outcomes (COs) with Program Specific Outcomes (PSOs):

CO / PSO	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	2	2	2	3
CO2	2	2	2	3
CO3	2	2	2	3
CO4	2	2	2	3
CO5	2	2	2	3

Mapping Scale: 3 = Strong / High; 2 = Moderate / Medium; 1 = Substantial / Low.

SEMESTER – II

NME – I - DATA LITERACY AND EVERYDAY BUSINESS ANALYTICS

Course Objectives:

The main objectives of this course are to:

1. Understand the difference between data and information and basic descriptive statistics.
2. Build spreadsheet-based analytical tools using pivot tables and summary functions.
3. Apply principles of effective data visualization for clear storytelling.
4. Understand common business analytics metrics used in marketing and operations.
5. Understand the basics of hypothesis testing and data-driven decision making.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Differentiate data from information and compute basic descriptive statistics.	K1, K2
2	Build pivot tables and spreadsheet summaries for everyday business reporting.	K2, K3
3	Design clear, well-labeled charts and dashboards for data storytelling.	K3, K4
4	Compute standard business metrics such as customer lifetime value and conversion rate.	K4, K5
5	Apply basic hypothesis testing logic to support data-driven business decisions.	K5, K6

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

Unit:1	**Foundations of Data Literacy**	**6 hours**

Data vs Information - Types of Data (Quantitative and Qualitative) - Basic Data Collection Methods - Mean, Median, and Mode - Common Cognitive Biases in Data Interpretation - Basic Data Cleaning Steps.

Unit:2	**Spreadsheet Analytics**	**6 hours**

Standard Deviation and Range - Percentiles and Frequency Distributions - Pivot Tables in Spreadsheets - Filters and Slicers - Building Simple Dashboards - Automating Routine Reports.

Unit:3	**Data Visualization for Storytelling**	**6 hours**

Choosing the Right Chart Type - Principles of Visual Design (Gestalt Principles) - Interactive Dashboards (Power BI / Tableau Basics) - Avoiding Misleading Visualizations - Telling a Story with Data - Designing

for the Audience.		
Unit:4	**Business Analytics Metrics**	**6 hours**
Customer Acquisition Cost and Lifetime Value - Customer Churn and Retention - Return on Investment (ROI) - A/B Testing Basics - Conversion Funnel Analysis - Market Basket Analysis Basics.		
Unit:5	**Data-Driven Decision Making**	**6 hours**
Basics of Hypothesis Testing - Correlation vs Causation - Data-Driven Strategy Formulation - Data Governance and Compliance Basics - Data Democratization - Ethical Use of Business Data.		

Mapping of Course Outcomes (COs) with Program Outcomes (POs):

CO / PO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	1	1	1
CO2	3	3	2	1	1
CO3	2	3	3	1	1
CO4	3	2	2	1	2
CO5	3	3	1	2	1

Mapping Scale: 3 = Strong / High; 2 = Moderate / Medium; 1 = Substantial / Low.

Mapping of Course Outcomes (COs) with Program Specific Outcomes (PSOs):

CO / PSO	PSO1	PSO2	PSO3	PSO4
CO1	1	2	1	3
CO2	2	1	1	3
CO3	2	1	1	3
CO4	1	1	1	3
CO5	1	2	1	3

Mapping Scale: 3 = Strong / High; 2 = Moderate / Medium; 1 = Substantial / Low.

Text Books:

- Jordan Morrow, 'Be Data Literate: The Data Literacy Skills Everyone Needs to Succeed', Kogan Page, 2021. (Covers Units: I, II, V) https://books.google.com/books?q=Be+Data+Literate%3A+The+Data+Literacy+Skills+Everyone+Needs+to+Succeed+Jordan+Morrow
- Cole Nussbaumer Knaflic, 'Storytelling with Data: A Data Visualization Guide for Business Professionals', Wiley, 2015. (Covers Units: III, IV) https://books.google.com/books?q=Storytelling+with+Data%3A+A+Data+Visualization+Guide+for+Business+Professionals+Cole+Nussbaumer+Knaflic

Reference Books:

- Wayne L. Winston, 'Microsoft Excel Data Analysis and Business Modeling', 7th Ed., Microsoft Press, 2021. https://books.google.com/books?q=Microsoft+Excel+Data+Analysis+and+Business+Modeling+Wayne+L.+Winston
- Alberto Cairo, 'The Truthful Art: Data, Charts, and Maps for Communication', 1st Ed., New Riders, 2016. https://books.google.com/books?q=The+Truthful+Art%3A+Data%2C+Charts%2C+and+Maps+for+Communication+Alberto+Cairo

Free Online Study Resources:

- Google Data Analytics resources, free official learning materials (Free) - https://grow.google/certificates/data-analytics/
- NPTEL - Business Analytics and Data Mining (IIT Roorkee), free video lectures with downloadable PDF notes (Free) - https://nptel.ac.in/courses/110107092

SEMESTER – II FUNDAMENTALS OF HUMAN RIGHTS

Course Objectives:

The main objectives of this course are to:

1. Understand the meaning, nature, and classification of human rights.
2. Learn about human rights protections under the Indian Constitution.
3. Understand the major international human rights instruments.
4. Learn about the institutions responsible for protecting human rights in India.
5. Understand human rights issues in the context of modern technology and society.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Explain the meaning, nature, and classification of human rights.	K1, K2
2	Describe the Fundamental Rights and Directive Principles under the Indian Constitution.	K2, K3
3	Explain major international human rights instruments and the role of the United Nations.	K3, K4
4	Describe the role of the National Human Rights Commission and other institutions in protecting rights.	K4, K5
5	Discuss human rights issues related to technology and contemporary society.	K5, K6

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

Unit:1	**Introduction to Human Rights**	**6 hours**

Meaning, definition, and nature of human rights - Historical evolution of human rights - Classification of human rights (civil, political, economic, social, and cultural) - Characteristics of human rights.

Unit:2	**Human Rights and the Indian Constitution**	**6 hours**

Fundamental Rights under the Indian Constitution - Directive Principles of State Policy - Fundamental Duties - Constitutional remedies for the protection of rights (Article 32 and Article 226).

Unit:3	**International Human Rights Instruments**	**6 hours**

Universal Declaration of Human Rights (UDHR) - International Covenant on Civil and Political Rights

(ICCPR) - International Covenant on Economic, Social and Cultural Rights (ICESCR) - Role of the United Nations in promoting human rights.		
Unit:4	**Human Rights Institutions in India**	**6 hours**
National Human Rights Commission (NHRC) - State Human Rights Commissions - National Commission for Women - National Commission for Scheduled Castes and Scheduled Tribes - Role of the judiciary in protecting human rights.		
Unit:5	**Human Rights and Contemporary Issues**	**6 hours**
Women's rights and child rights - Rights of persons with disabilities - Human rights in the context of technology (privacy, data protection, and AI ethics) - Common human rights violations and redressal mechanisms.		

Mapping of Course Outcomes (COs) with Program Outcomes (POs):

CO / PO	PO1	PO2	PO3	PO4	PO5
CO1	1	1	1	3	1
CO2	1	1	1	3	1
CO3	1	1	1	3	1
CO4	1	1	1	3	1
CO5	1	1	2	3	1

Mapping Scale: 3 = Strong / High; 2 = Moderate / Medium; 1 = Substantial / Low.

Mapping of Course Outcomes (COs) with Program Specific Outcomes (PSOs):

CO / PSO	PSO1	PSO2	PSO3	PSO4
CO1	1	1	1	2
CO2	1	1	1	2
CO3	1	1	1	2
CO4	1	1	1	2
CO5	1	1	2	2

Mapping Scale: 3 = Strong / High; 2 = Moderate / Medium; 1 = Substantial / Low.

Text Books:

- Dr. H. O. Agarwal, 'International Law and Human Rights', 21st Ed., Central Law Publications, 2022. (Covers Units: I - V) https://books.google.com/books?q=International+Law+and+Human+Rights+Dr.+H.+O.+Agarwal
- Dr. J. N. Pandey, 'Constitutional Law of India', 60th Ed., Central Law Agency, 2023. (Covers Units: I - V) https://books.google.com/books?q=Constitutional+Law+of+India+Dr.+J.+N.+Pandey

Reference Books:

- C. J. Nirmal (Ed.), 'Human Rights in India: Historical, Social and Political Perspectives', Oxford University Press, 2000. https://books.google.com/books?q=Human+Rights+in+India%3A+Historical%2C+Social+and+Political+Perspectives+C.+J.+Nirmal+%28Ed.%29
- Upendra Baxi, 'The Future of Human Rights', 4th Ed., Oxford University Press, 2018. https://books.google.com/books?q=The+Future+of+Human+Rights+Upendra+Baxi

Free Online Study Resources:

- United Nations Human Rights Office of the High Commissioner (OHCHR), free publications (Free) - https://www.ohchr.org/en/publications
- National Human Rights Commission, India, free publications (Free) - https://nhrc.nic.in/publications/latest-released-publications

SEMESTER – III
CORE – V - BIG DATA ENGINEERING

Course Objectives:

The main objectives of this course are to:

1. Understand the characteristics of big data and distributed storage using Hadoop/HDFS.
2. Understand the MapReduce programming model and resource management with YARN.
3. Apply Apache Spark for distributed data processing and analysis.
4. Understand NoSQL database models and their use cases.
5. Understand real-time stream processing using Kafka and Spark Streaming.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Explain the characteristics of big data and the architecture of HDFS.	K1, K2
2	Develop MapReduce programs and understand YARN resource management.	K2, K3
3	Process large-scale data using Apache Spark RDDs and DataFrames.	K3, K4
4	Select and apply appropriate NoSQL database models for given use cases.	K4, K5
5	Design real-time streaming data pipelines using Kafka and Spark Streaming.	K5, K6

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

Unit:1	**Big Data and Hadoop Distributed File System**	**15 hours**

Characteristics of Big Data (Volume, Velocity, Variety) - Hadoop Ecosystem Overview - HDFS Architecture (NameNode, DataNode) - Data Replication and Fault Tolerance - Rack Awareness - HDFS Commands and File Operations.

Unit:2	**MapReduce and YARN**	**15 hours**

MapReduce Programming Model - Map, Shuffle, and Reduce Phases - Writing Basic MapReduce Programs - YARN Architecture and Resource Management - Job Scheduling (FIFO, Capacity, Fair Scheduler) - Fault Tolerance in MapReduce.

Unit:3	**Apache Spark**	**15 hours**

Resilient Distributed Datasets (RDDs) - Spark Transformations and Actions - Spark SQL and DataFrames -

Lazy Evaluation and Directed Acyclic Graphs (DAG) - Spark Caching and Persistence - Broadcast Variables and Accumulators.		
Unit:4	**NoSQL Databases**	**15 hours**
CAP Theorem - Key-Value Stores - Column-Family Stores (HBase) - Document Stores (MongoDB) - Graph Databases Overview - Choosing the Right Database for the Use Case (Polyglot Persistence).		
Unit:5	**Stream Processing**	**15 hours**
Introduction to Apache Kafka - Kafka Topics, Partitions, and Producers/Consumers - Spark Structured Streaming - Windowed Stream Processing - Lambda and Kappa Architecture Overview - Building a Simple End-to-End Streaming Pipeline.		

Mapping of Course Outcomes (COs) with Program Outcomes (POs):

CO / PO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	2	1	1
CO2	3	3	2	1	2
CO3	3	3	2	1	1
CO4	3	3	2	1	1
CO5	3	3	2	1	2

Mapping Scale: 3 = Strong / High; 2 = Moderate / Medium; 1 = Substantial / Low.

Mapping of Course Outcomes (COs) with Program Specific Outcomes (PSOs):

CO / PSO	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	1
CO2	3	3	2	1
CO3	3	3	2	1
CO4	3	2	2	1
CO5	3	3	2	2

Mapping Scale: 3 = Strong / High; 2 = Moderate / Medium; 1 = Substantial / Low.

Text Books:

- Tom White, 'Hadoop: The Definitive Guide', 4th Ed., O'Reilly Media, 2015. (Covers Units: I, II, IV) https://books.google.com/books?q=Hadoop%3A+The+Definitive+Guide+Tom+White
- Bill Chambers, Matei Zaharia, 'Spark: The Definitive Guide: Big Data Processing Made Simple', O'Reilly Media, 2018. (Covers Units: III, V) https://books.google.com/books?q=Spark%3A+The+Definitive+Guide%3A+Big+Data+Processing+Made+Simple+Bill+Chambers%2C+Matei+Zaharia

Reference Books:

- Pramod J. Sadalage, Martin Fowler, 'NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence', Addison-Wesley, 2012. https://books.google.com/books?q=NoSQL+Distilled%3A+A+Brief+Guide+to+the+Emerging+World+of+Polyglot+Persistence+Pramod+J.+Sadalage%2C+Martin+Fowler
- Gwen Shapira, Todd Palino, Rajini Sivaram, Krit Petty, 'Kafka: The Definitive Guide', 2nd Ed., O'Reilly Media, 2021. https://books.google.com/books?q=Kafka%3A+The+Definitive+Guide+Gwen+Shapira%2C+Todd+Palino%2C+Rajini+Sivaram%2C+Krit+Petty
- Nathan Marz, James Warren, 'Big Data: Principles and Best Practices of Scalable Realtime Data Systems', 1st Ed., Manning Publications, 2015. https://books.google.com/books?q=Big+Data%3A+Principles+and+Best+Practices+of+Scalable+Realtime+Data+Systems+Nathan+Marz%2C+James+Warren

Free Online Study Resources:

- Apache Spark official documentation, free comprehensive guide (Free) - https://spark.apache.org/docs/latest/
- NPTEL - Big Data Computing (IIT Patna), free video lectures with downloadable PDF notes (Free) - https://nptel.ac.in/courses/106104189

SEMESTER – III
CORE – VI - DIGITAL IMAGE PROCESSING AND COMPUTER VISION

Course Objectives:

The main objectives of this course are to:

1. Understand digital image representation and basic image processing operations.
2. Apply spatial domain techniques for image enhancement and filtering.
3. Apply frequency domain techniques for image analysis.
4. Apply image segmentation and morphological operations.
5. Apply classical feature detection techniques for computer vision tasks.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Explain digital image representation and basic color models.	K1, K2
2	Apply spatial domain filters for image smoothing, sharpening, and edge detection.	K2, K3
3	Apply Fourier Transform techniques for frequency domain image filtering.	K3, K4
4	Apply thresholding, morphological operations, and segmentation algorithms.	K4, K5
5	Implement classical feature detection and matching techniques for vision applications.	K5, K6

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

Unit: 1	**Digital Image Fundamentals**	**15 hours**

Image Sensing and Acquisition - Sampling and Quantization - Pixel Relationships and Connectivity - Color Models (RGB, HSV, Grayscale) - Image File Formats - Basic Image Interpolation Techniques.

Unit: 2	**Spatial Domain Image Enhancement**	**15 hours**

Histogram Equalization - Contrast Limited Adaptive Histogram Equalization (CLAHE) - Spatial Filtering (Smoothing, Sharpening) - Gaussian and Bilateral Filters - Canny Edge Detection - Laplacian Sharpening.

Unit:	**Frequency Domain Processing**	**15 hours**

3		
2D Discrete Fourier Transform - Fast Fourier Transform (FFT) Basics - Low-Pass and High-Pass Filtering - Butterworth and Gaussian Frequency Filters - Image Restoration Basics - Introduction to Wavelet Transform.		
Unit: 4	**Image Segmentation and Morphology**	**15 hours**
Otsu's Thresholding Method - Morphological Operations (Dilation, Erosion, Opening, Closing) - Hit-or-Miss Transform - Watershed Segmentation - Active Contour (Snake) Models - Region-Based Segmentation.		
Unit: 5	**Feature Detection and Computer Vision**	**15 hours**
Harris Corner Detection - Scale-Invariant Feature Transform (SIFT) - Speeded-Up Robust Features (SURF) Overview - Histogram of Oriented Gradients (HOG) - RANSAC for Robust Geometric Estimation - Basics of Object Tracking.		

Mapping of Course Outcomes (COs) with Program Outcomes (POs):

CO / PO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	1	1	1
CO2	3	3	2	1	1
CO3	3	3	1	1	2
CO4	3	3	2	1	1
CO5	3	3	2	1	2

Mapping Scale: 3 = Strong / High; 2 = Moderate / Medium; 1 = Substantial / Low.

Mapping of Course Outcomes (COs) with Program Specific Outcomes (PSOs):

CO / PSO	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	1
CO2	3	3	2	1
CO3	3	3	1	2

CO4	3	3	2	1
CO5	3	3	2	2

Mapping Scale: 3 = Strong / High; 2 = Moderate / Medium; 1 = Substantial / Low.

Text Books:

- Rafael C. Gonzalez, Richard E. Woods, 'Digital Image Processing', 4th Ed., Pearson, 2018. (Covers Units: I - IV) https://books.google.com/books?q=Digital+Image+Processing+Rafael+C.+Gonzalez%2C+Richard+E.+Woods
- Gary Bradski, Adrian Kaehler, 'Learning OpenCV 3: Computer Vision in C++ with the OpenCV Library', 1st Ed., O'Reilly Media, 2017. (Covers Units: I - V) https://books.google.com/books?q=Learning+OpenCV+3%3A+Computer+Vision+in+C%2B%2B+with+the+OpenCV+Library+Gary+Bradski%2C+Adrian+Kaehler

Reference Books:

- Richard Szeliski, 'Computer Vision: Algorithms and Applications', 2nd Ed., Springer, 2022. https://books.google.com/books?q=Computer+Vision%3A+Algorithms+and+Applications+Richard+Szeliski
- Milan Sonka, Vaclav Hlavac, Roger Boyle, 'Image Processing, Analysis, and Machine Vision', 4th Ed., Cengage Learning, 2014. https://books.google.com/books?q=Image+Processing%2C+Analysis%2C+and+Machine+Vision+Milan+Sonka%2C+Vaclav+Hlavac%2C+Roger+Boyle

Free Online Study Resources:

- Computer Vision: Algorithms and Applications, free official online draft by Richard Szeliski (Free) - https://szeliski.org/Book/
- NPTEL - Digital Image Processing (IIT Kharagpur / IIT Roorkee), free video lectures with downloadable PDF notes (Free) - https://nptel.ac.in/courses/117105079

SEMESTER – III
ELECTIVE – III - SPATIAL-TEMPORAL DATA MINING AND GIS ANALYTICS

Course Objectives:

The main objectives of this course are to:

1. Understand geographic data models and coordinate reference systems.
2. Understand spatial indexing structures used for efficient geographic queries.
3. Apply spatial statistics techniques to detect patterns in geographic data.
4. Apply trajectory analysis techniques to mine moving-object data.
5. Use Python GIS libraries to build spatial data analysis pipelines.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Explain raster and vector geographic data models and coordinate reference systems.	K1, K2
2	Apply spatial indexing structures (R-Tree, Quad-Tree) for efficient spatial queries.	K2, K3
3	Apply spatial autocorrelation and regression techniques to geographic datasets.	K3, K4
4	Analyze trajectory data to identify movement patterns and clusters.	K4, K5
5	Build end-to-end spatial data analysis and visualization pipelines using Python GIS tools.	K5, K6

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

Unit:1	**Geographic Data Fundamentals**	**12 hours**

Geographic Information Systems (GIS) Overview - Raster vs Vector Data Models - Coordinate Reference Systems and Map Projections - Spatial Data File Formats (Shapefile, GeoJSON) - Spatial Relationships (Topology) - Spatial Metadata.

Unit:2	**Spatial Indexing**	**12 hours**

R-Tree Indexing - Quad-Tree Spatial Partitioning - k-d Tree for Nearest-Neighbor Search - Point-in-Polygon Queries - Spatial Join Operations - k-Nearest Neighbor Search on Geographic Data.

Unit:3	**Spatial Statistics**	**12 hours**

Tobler's First Law of Geography - Spatial Autocorrelation (Moran's I) - Geary's C Statistic - Spatial Regression Models - Geographically Weighted Regression - Kriging and Spatial Interpolation.		
Unit:4	**Trajectory Data Mining**	**12 hours**
Trajectory Data Representation - Dynamic Time Warping for Trajectory Comparison - Trajectory Clustering (TRACLUS) - Stop-and-Move Pattern Extraction - Spatio-Temporal Pattern Mining - Applications in Urban Mobility Analysis.		
Unit:5	**GIS Tools and Visualization**	**12 hours**
GeoPandas for Spatial Data Processing - Shapely for Geometric Operations - PostGIS Overview - Folium for Interactive Map Visualization - Building Web-Based Spatial Dashboards - Case Study: Mapping Real-World Geographic Data.		

Mapping of Course Outcomes (COs) with Program Outcomes (POs):

CO / PO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	1	1	1
CO2	3	3	2	1	1
CO3	3	3	1	1	2
CO4	3	3	1	1	2
CO5	2	3	3	1	1

Mapping Scale: 3 = Strong / High; 2 = Moderate / Medium; 1 = Substantial / Low.

Mapping of Course Outcomes (COs) with Program Specific Outcomes (PSOs):

CO / PSO	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	1
CO2	3	3	2	1
CO3	3	3	1	2
CO4	3	3	1	2

CO5	2	3	3	1

Mapping Scale: 3 = Strong / High; 2 = Moderate / Medium; 1 = Substantial / Low.

Text Books:

- Shashi Shekhar, Sanjay Chawla, 'Spatial Databases: A Tour', Pearson, 2003. (Covers Units: I, II) https://books.google.com/books?q=Spatial+Databases%3A+A+Tour+Shashi+Shekhar%2C+Sanjay+Chawla
- Harvey J. Miller, Jiawei Han, 'Geographic Data Mining and Knowledge Discovery', 2nd Ed., CRC Press, 2009. (Covers Units: III, IV, V) https://books.google.com/books?q=Geographic+Data+Mining+and+Knowledge+Discovery+Harvey+J.+Miller%2C+Jiawei+Han

Reference Books:

- Paul A. Longley, Michael F. Goodchild, David J. Maguire, David W. Rhind, 'Geographic Information Systems and Science', 4th Ed., Wiley, 2015. https://books.google.com/books?q=Geographic+Information+Systems+and+Science+Paul+A.+Longley%2C+Michael+F.+Goodchild%2C+David+J.+Maguire%2C+David+W.+Rhind
- Yu Zheng, Xiaofang Zhou (Eds.), 'Computing with Spatial Trajectories', 1st Ed., Springer, 2011. https://books.google.com/books?q=Computing+with+Spatial+Trajectories+Yu+Zheng%2C+Xiaofang+Zhou+%28Eds.%29

Free Online Study Resources:

- GeoPandas official documentation, free comprehensive guide (Free) - https://geopandas.org/en/stable/
- NPTEL - Geoinformatics (IIT Roorkee), free video lectures with downloadable PDF notes (Free) - https://nptel.ac.in/courses/105105191

SEMESTER – III

ELECTIVE – III (OPTION) - CLOUD NATIVE COMPUTING AND VIRTUALIZATION

Course Objectives:

The main objectives of this course are to:

1. Understand virtualization concepts and cloud service models.
2. Understand containerization concepts using Docker.
3. Understand container orchestration concepts using Kubernetes.
4. Understand cloud-native application design principles.
5. Understand monitoring, automation, and deployment practices for cloud-native systems.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Explain virtualization concepts and compare cloud service and deployment models.	K1, K2
2	Build and manage containerized applications using Docker.	K2, K3
3	Deploy and manage containerized applications using Kubernetes.	K3, K4
4	Design cloud-native applications following the twelve-factor methodology.	K4, K5
5	Implement monitoring and automated deployment pipelines for cloud-native systems.	K5, K6

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

Unit:1	**Virtualization and Cloud Fundamentals**	**12 hours**

Hypervisors: Type 1 and Type 2 - Virtual Machines vs Containers - Cloud Service Models (IaaS, PaaS, SaaS) - Cloud Deployment Models (Public, Private, Hybrid) - Multi-Tenancy and Resource Isolation - Cloud Security Basics.

Unit:2	**Containerization with Docker**	**12 hours**

Docker Architecture and Components - Building Docker Images (Dockerfile) - Docker Networking Basics - Docker Volumes and Persistent Storage - Multi-Container Applications with Docker Compose - Container Registries.

Unit:3	Kubernetes Fundamentals	12 hours
Kubernetes Architecture (Control Plane, Nodes) - Pods, Deployments, and ReplicaSets - Kubernetes Services and Load Balancing - Ingress Controllers - Persistent Volumes and Storage Classes - ConfigMaps and Secrets.		
Unit:4	**Cloud-Native Application Design**	**12 hours**
The Twelve-Factor App Methodology - Microservices Architecture Basics - API Gateways - Service Mesh Concepts - Event-Driven Architecture - Serverless Computing and Auto-Scaling Basics.		
Unit:5	**DevOps and Monitoring**	**12 hours**
Continuous Integration and Continuous Delivery (CI/CD) Pipelines - Infrastructure as Code Basics - Monitoring with Prometheus - Visualization with Grafana - Distributed Tracing Basics - GitOps and Declarative Deployment.		

Mapping of Course Outcomes (COs) with Program Outcomes (POs):

CO / PO	PO1	PO2	PO3	PO4	PO5
CO1	2	2	3	2	1
CO2	1	2	3	1	2
CO3	1	2	3	1	1
CO4	2	2	3	2	1
CO5	1	2	3	1	2

Mapping Scale: 3 = Strong / High; 2 = Moderate / Medium; 1 = Substantial / Low.

Mapping of Course Outcomes (COs) with Program Specific Outcomes (PSOs):

CO / PSO	PSO1	PSO2	PSO3	PSO4
CO1	1	2	3	1
CO2	1	1	3	1
CO3	1	2	3	1
CO4	2	2	3	1

CO5	1	2	3	1

Mapping Scale: 3 = Strong / High; 2 = Moderate / Medium; 1 = Substantial / Low.

Text Books:

- Karl Matthias, Sean P. Kane, 'Docker: Up and Running', 3rd Ed., O'Reilly Media, 2022. (Covers Units: I, II) https://books.google.com/books?q=Docker%3A+Up+and+Running+Karl+Matthias%2C+Sean+P.+Kane
- Kelsey Hightower, Brendan Burns, Joe Beda, 'Kubernetes: Up and Running', 3rd Ed., O'Reilly Media, 2022. (Covers Units: III, IV, V) https://books.google.com/books?q=Kubernetes%3A+Up+and+Running+Kelsey+Hightower%2C+Brendan+Burns%2C+Joe+Beda

Reference Books:

- Brendan Burns, 'Designing Distributed Systems: Patterns and Paradigms for Scalable, Reliable Services', O'Reilly Media, 2018. https://books.google.com/books?q=Designing+Distributed+Systems%3A+Patterns+and+Paradigms+for+Scalable%2C+Reliable+Services+Brendan+Burns
- John Arundel, Justin Domingus, 'Cloud Native DevOps with Kubernetes', 2nd Ed., O'Reilly Media, 2022. https://books.google.com/books?q=Cloud+Native+DevOps+with+Kubernetes+John+Arundel%2C+Justin+Domingus

Free Online Study Resources:

- Kubernetes official documentation, free comprehensive guide (Free) - https://kubernetes.io/docs/home/
- Docker official documentation, free comprehensive guide (Free) - https://docs.docker.com/

SEMESTER – III
PRACTICAL – V - BIG DATA ENGINEERING LAB

Learning Objective (LO):

To provide hands-on practice with distributed storage, distributed processing, and stream processing tools used in big data engineering.

List of Programs:

01. Set up a single-node Hadoop environment and perform basic HDFS file operations (copy, move, list).

02. Write and execute a basic MapReduce program to compute word frequency from a text dataset.

03. Monitor job execution and resource allocation in the Hadoop cluster using the YARN web interface.

04. Create and transform Resilient Distributed Datasets (RDDs) using PySpark.

05. Perform data analysis using Spark SQL and DataFrame operations on a structured dataset.

06. Implement a Spark Structured Streaming job to process data from a simulated streaming source.

07. Perform basic CRUD operations on a column-family NoSQL database (HBase or equivalent).

08. Perform basic CRUD and aggregation operations on a document-oriented NoSQL database (MongoDB).

09. Set up a basic Apache Kafka producer and consumer to publish and read streaming messages.

10. Design a simple end-to-end pipeline that ingests, processes, and stores streaming data.

Expected Course Outcomes:

On the successful completion of this practical course, student will be able to:

1	CO1: Set up an HDFS environment and perform basic distributed file operations.	K1, K2
2	CO2: Develop MapReduce programs and monitor resource allocation using YARN.	K2, K3
3	CO3: Process large datasets using Spark RDDs, DataFrames, and Spark SQL.	K3, K4
4	CO4: Perform CRUD and aggregation operations on column-family and document NoSQL databases.	K4, K5
5	CO5: Build streaming pipelines using Apache Kafka and Spark Structured Streaming.	K5, K6

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

Mapping of Course Outcomes (COs) with Program Outcomes (POs):

CO / PO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	2	1	1
CO2	3	3	2	1	2
CO3	3	3	2	1	1
CO4	3	3	2	1	1
CO5	3	3	2	1	2

Mapping Scale: 3 = Strong / High; 2 = Moderate / Medium; 1 = Substantial / Low.

Mapping of Course Outcomes (COs) with Program Specific Outcomes (PSOs):

CO / PSO	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	1
CO2	3	3	2	1
CO3	3	3	2	1
CO4	3	2	2	1
CO5	3	3	2	2

Mapping Scale: 3 = Strong / High; 2 = Moderate / Medium; 1 = Substantial / Low.

SEMESTER – III

PRACTICAL – VI - DIGITAL IMAGE PROCESSING AND COMPUTER VISION LAB

Learning Objective (LO):

To provide hands-on practice in image enhancement, frequency domain filtering, segmentation, and classical feature detection using Python and OpenCV.

List of Programs:

01. Perform color space conversions (RGB, HSV, Grayscale) and display the converted images.

02. Apply histogram equalization and CLAHE to enhance the contrast of a low-contrast image.

03. Apply Gaussian and bilateral filters for image smoothing and compare their effects on edge preservation.

04. Implement Canny edge detection and compare results against Sobel and Laplacian edge detectors.

05. Apply 2D Discrete Fourier Transform and implement low-pass and high-pass filtering in the frequency domain.

06. Apply Otsu's thresholding method to segment an image into foreground and background regions.

07. Apply morphological operations (dilation, erosion, opening, closing) on a binary image.

08. Implement Watershed segmentation to separate touching objects in an image.

09. Detect and visualize SIFT keypoints and descriptors on a sample image.

10. Implement feature matching between two images using SIFT descriptors and the RANSAC algorithm.

Expected Course Outcomes:

On the successful completion of this practical course, student will be able to:

1	CO1: Convert images between color spaces and apply histogram-based contrast enhancement.	K1, K2
2	CO2: Apply spatial filters and edge detection techniques for image enhancement.	K2, K3
3	CO3: Apply frequency domain filtering using the Fourier Transform on sample images.	K3, K4
4	CO4: Implement thresholding, morphological operations, and segmentation	K4, K5

	techniques.	
5	CO5: Detect and match classical image features using SIFT and RANSAC.	K5, K6
K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create		

Mapping of Course Outcomes (COs) with Program Outcomes (POs):

CO / PO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	1	1	1
CO2	3	3	2	1	1
CO3	3	3	1	1	2
CO4	3	3	2	1	1
CO5	3	3	2	1	2

Mapping Scale: 3 = Strong / High; 2 = Moderate / Medium; 1 = Substantial / Low.

Mapping of Course Outcomes (COs) with Program Specific Outcomes (PSOs):

CO / PSO	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	1
CO2	3	3	2	1
CO3	3	3	1	2
CO4	3	3	2	1
CO5	3	3	2	2

Mapping Scale: 3 = Strong / High; 2 = Moderate / Medium; 1 = Substantial / Low.

SEMESTER – III

SEC - DATA VISUALIZATION TOOLS LABORATORY (TABLEAU / POWER BI)

Learning Objective (LO):

To provide hands-on practice in data preparation, visual analytics, and interactive dashboard design using Tableau and Power BI.

List of Programs:

01. Explore the Tableau / Power BI interface and connect to data sources (Excel, CSV, and a relational database).
02. Perform data cleaning and preparation using the Data Interpreter / Power Query Editor.
03. Create bar charts, line charts, and pie charts to summarize categorical and time-series data.
04. Design heat maps, tree maps, and bubble charts for multi-dimensional data analysis.
05. Apply filters, sorting, and grouping to refine and organize data views.
06. Create calculated fields and measures to derive new metrics from raw data.
07. Build an interactive dashboard combining multiple worksheets with highlight actions.
08. Use parameters and actions to create dynamic, user-driven dashboards.
09. Create geographic map visualizations for location-based datasets.
10. Design a data story / report and publish and share the completed dashboard.

Expected Course Outcomes:

On the successful completion of this practical course, student will be able to:

1	CO1: Import, clean, and prepare data from multiple sources for visualization.	K1, K2
2	CO2: Design appropriate charts and graphs to represent categorical and numerical data.	K2, K3
3	CO3: Apply calculated fields and filters to derive meaningful insights from data.	K3, K4
4	CO4: Build interactive dashboards using parameters and actions.	K4, K5
5	CO5: Publish and present data stories for effective communication of insights.	K5, K6

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

Mapping of Course Outcomes (COs) with Program Outcomes (POs):

CO / PO	PO1	PO2	PO3	PO4	PO5
CO1	3	2	1	1	1
CO2	3	3	2	1	1
CO3	3	3	2	1	2
CO4	3	3	2	2	1
CO5	3	3	1	2	2

Mapping Scale: 3 = Strong / High; 2 = Moderate / Medium; 1 = Substantial / Low.

Mapping of Course Outcomes (COs) with Program Specific Outcomes (PSOs):

CO / PSO	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	1
CO2	3	3	2	1
CO3	3	3	1	2
CO4	3	3	2	1
CO5	3	3	2	2

Mapping Scale: 3 = Strong / High; 2 = Moderate / Medium; 1 = Substantial / Low.

SEMESTER – III
NME – II - ARTIFICIAL INTELLIGENCE ETHICS, TRENDS, AND DIGITAL SOCIETY

Course Objectives:

The main objectives of this course are to:

1. Understand fundamental concepts of AI ethics and sources of algorithmic bias.
2. Understand explainability and fairness techniques for AI systems.
3. Understand the societal impact of AI technologies.
4. Understand global and national AI governance frameworks.
5. Understand emerging trends and the long-term societal implications of AI.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Explain core concepts of machine ethics and identify sources of algorithmic bias.	K1, K2
2	Apply basic explainability techniques to interpret model predictions.	K2, K3
3	Analyze the societal impact of AI on employment, media, and information access.	K3, K4
4	Evaluate AI systems against national and international governance frameworks.	K4, K5
5	Discuss emerging AI trends and their long-term implications for society.	K5, K6

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

Unit:1	**Foundations of AI Ethics**	**6 hours**

Machine Ethics: Key Concepts - Sources of Algorithmic Bias - Historical Bias in Training Data - The Black-Box Problem - Fairness in AI Systems - Disparate Impact Basics.

Unit:2	**Explainability and Fairness**	**6 hours**

Explainable AI (XAI) Overview - SHAP and LIME Basics - Fairness Metrics (Demographic Parity, Equal Opportunity) - Adversarial Robustness Basics - AI Governance within Organizations - Algorithmic Audits.

Unit:3	**AI and Society**	**6 hours**

Automation and the Future of Work - Deepfakes and Synthetic Media - Misinformation and Algorithmic Content Curation - Intellectual Property and Generative AI - The Digital Divide - Content Moderation

Challenges.		
Unit:4	**AI Governance and Regulation**	**6 hours**
Corporate AI Governance Practices - UNESCO Recommendation on AI Ethics - European Union AI Act Overview - India's AI Governance Guidelines - Institutional Review and Ethics Boards - National Data Governance Policy.		
Unit:5	**Emerging Trends and the Future**	**6 hours**
Towards Artificial General Intelligence: Key Debates - Human-in-the-Loop AI Systems - Green and Sustainable Computing - Long-Term Societal Forecasts - Decentralized and Open AI Systems - Responsible Innovation Practices.		

Mapping of Course Outcomes (COs) with Program Outcomes (POs):

CO / PO	PO1	PO2	PO3	PO4	PO5
CO1	2	2	1	3	2
CO2	2	1	2	3	1
CO3	1	1	1	3	2
CO4	1	2	1	3	1
CO5	2	1	1	3	2

Mapping Scale: 3 = Strong / High; 2 = Moderate / Medium; 1 = Substantial / Low.

Mapping of Course Outcomes (COs) with Program Specific Outcomes (PSOs):

CO / PSO	PSO1	PSO2	PSO3	PSO4
CO1	1	1	1	3
CO2	1	1	2	3
CO3	1	1	1	3
CO4	1	1	1	3
CO5	1	1	1	3

Mapping Scale: 3 = Strong / High; 2 = Moderate / Medium; 1 = Substantial / Low.

Text Books:

- Mark Coeckelbergh, 'AI Ethics', MIT Press, 2020. (Covers Units: I, II, III) https://books.google.com/books?q=AI+Ethics+Mark+Coeckelbergh
- Virginia Dignum, 'Responsible Artificial Intelligence: How to Develop and Use AI in a Responsible Way', Springer, 2019. (Covers Units: IV, V) https://books.google.com/books?q=Responsible+Artificial+Intelligence%3A+How+to+Develop+and+Use+AI+in+a+Responsible+Way+Virginia+Dignum

Reference Books:

- Cathy O'Neil, 'Weapons of Math Destruction: How Big Data Increases Inequality and Threatens Democracy', Crown Publishing, 2016. https://books.google.com/books?q=Neil%2C++Cathy+O
- Christoph Molnar, 'Interpretable Machine Learning: A Guide for Making Black Box Models Explainable', 3rd Ed., Self-Published (Leanpub), 2025. https://christophm.github.io/interpretable-ml-book/

Free Online Study Resources:

- UNESCO Recommendation on the Ethics of Artificial Intelligence, free official document (Free) - https://www.unesco.org/en/artificial-intelligence/recommendation-ethics
- NPTEL - Ethics in Engineering Practice (IIT Kharagpur), free video lectures with downloadable PDF notes (Free) - https://nptel.ac.in/courses/109104115

SEMESTER – IV
CORE – VII – ARTIFICIAL INTELLIGENCE FRAMEWORKS AND MLOps

Course Objectives:

The main objectives of this course are to:

1. Understand the PyTorch deep learning framework and automatic differentiation.
2. Apply transfer learning using pretrained models from the Hugging Face ecosystem.
3. Understand experiment tracking and reproducibility practices in machine learning projects.
4. Understand model deployment and optimization techniques for production systems.
5. Understand scalable data processing tools used in modern AI pipelines.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Build and train neural networks using PyTorch tensors and autograd.	K1, K2
2	Apply transfer learning using pretrained models from the Hugging Face Model Hub.	K2, K3
3	Track machine learning experiments and manage data versioning for reproducibility.	K3, K4
4	Deploy and optimize trained models for efficient production inference.	K4, K5
5	Build scalable data pipelines using modern columnar and distributed processing tools.	K5, K6

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

Unit:1	**PyTorch Fundamentals**	**15 hours**

PyTorch Tensors and Operations - Automatic Differentiation (Autograd) - Building Neural Networks with torch.nn - GPU Acceleration Basics - Training and Validation Loops - Saving and Loading Models.

Unit:2	**Transfer Learning and Pretrained Models**	**15 hours**

Introduction to PyTorch Lightning - The Hugging Face Model Hub - Loading and Fine-Tuning Pretrained Transformer Models - Transfer Learning Strategies (Feature Extraction vs Fine-Tuning) - Mixed Precision Training - Gradient Accumulation for Large Models.

Unit:3	**Experiment Tracking and Reproducibility**	**15 hours**

Introduction to MLflow for Experiment Tracking - Logging Metrics, Parameters, and Artifacts - Data Version Control (DVC) Basics - Building Automated Training Pipelines - Continuous Integration for ML Projects - Monitoring for Data and Model Drift.		
Unit:4	**Model Deployment and Optimization**	**15 hours**
Model Serialization Formats - Post-Training Quantization Basics - ONNX for Cross-Platform Model Representation - Serving Models with REST APIs - Introduction to High-Throughput Inference Servers - Batch vs Real-Time Inference.		
Unit:5	**Scalable Data Processing for AI**	**15 hours**
Polars for Fast DataFrame Processing - Introduction to Dask for Parallel Computing - Apache Arrow for In-Memory Data Interchange - Out-of-Core Data Processing Basics - Building End-to-End ETL Pipelines for ML - Best Practices for Reproducible AI Pipelines.		

Mapping of Course Outcomes (COs) with Program Outcomes (POs):

CO / PO	PO1	PO2	PO3	PO4	PO5
CO1	2	1	3	1	2
CO2	1	1	3	1	2
CO3	1	2	3	2	1
CO4	2	2	3	1	1
CO5	2	1	3	1	1

Mapping Scale: 3 = Strong / High; 2 = Moderate / Medium; 1 = Substantial / Low.

Mapping of Course Outcomes (COs) with Program Specific Outcomes (PSOs):

CO / PSO	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	1
CO2	3	2	2	1
CO3	2	3	2	1

CO4	2	3	2	1
CO5	3	2	2	1

Mapping Scale: 3 = Strong / High; 2 = Moderate / Medium; 1 = Substantial / Low.

Text Books:

- Eli Stevens, Luca Antiga, Thomas Viehmann, 'Deep Learning with PyTorch', Manning Publications, 2020. (Covers Units: I, II) https://www.deeplearningbook.org/
- Noah Gift, Alfredo Deza, 'Practical MLOps: Operationalizing Machine Learning Models', O'Reilly Media, 2021. (Covers Units: III, IV, V) https://books.google.com/books?q=Practical+MLOps%3A+Operationalizing+Machine+Learning+Models+Noah+Gift%2C+Alfredo+Deza

Reference Books:

- Lewis Tunstall, Leandro von Werra, Thomas Wolf, 'Natural Language Processing with Transformers', O'Reilly Media, 2022. https://books.google.com/books?q=Natural+Language+Processing+with+Transformers+Lewis+Tunstall%2C+Leandro+von+Werra%2C+Thomas+Wolf
- Chip Huyen, 'Designing Machine Learning Systems: An Iterative Process for Production-Ready Applications', 1st Ed., O'Reilly Media, 2022. https://books.google.com/books?q=Designing+Machine+Learning+Systems%3A+An+Iterative+Process+for+Production-Ready+Applications+Chip+Huyen

Free Online Study Resources:

- PyTorch official tutorials, free comprehensive documentation (Free) - https://pytorch.org/tutorials/
- MLflow official documentation, free comprehensive guide (Free) - https://mlflow.org/docs/latest/index.html

SEMESTER – IV
PRACTICAL – VII - AI TOOLS, FRAMEWORKS, AND MLOPS LAB

Learning Objective (LO):

To provide hands-on practice in building models with PyTorch, tracking experiments, and deploying models using modern MLOps tools.

List of Programs:

01. Create and manipulate PyTorch tensors, and compute gradients using autograd on a simple function.
02. Build and train a basic neural network in PyTorch using the torch.nn module.
03. Fine-tune a pretrained transformer model from the Hugging Face Model Hub on a sample text classification task.
04. Train a model using mixed precision and compare training speed against standard precision.
05. Track training experiments (parameters, metrics, and artifacts) using MLflow.
06. Set up basic data version control (DVC) for a sample dataset used in a training pipeline.
07. Convert a trained PyTorch model to ONNX format and verify its outputs against the original model.
08. Apply post-training quantization to a trained model and compare model size and inference speed.
09. Deploy a trained model as a REST API endpoint and test it with sample requests.
10. Build a basic ETL pipeline using Polars or Dask to process a large dataset efficiently.

Expected Course Outcomes:

On the successful completion of this practical course, student will be able to:

1	CO1: Create PyTorch tensors and compute gradients using automatic differentiation.	K1, K2
2	CO2: Build, train, and fine-tune neural network and transformer models using PyTorch and Hugging Face.	K2, K3
3	CO3: Track experiments and manage data versions using MLflow and DVC.	K3, K4
4	CO4: Convert and optimize trained models for efficient deployment using ONNX and quantization.	K4, K5
5	CO5: Deploy models as REST APIs and build scalable ETL pipelines for AI	K5, K6

	workflows.	
K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create		

Mapping of Course Outcomes (COs) with Program Outcomes (POs):

CO / PO	PO1	PO2	PO3	PO4	PO5
CO1	2	1	3	1	2
CO2	1	1	3	1	2
CO3	1	2	3	2	1
CO4	2	2	3	1	1
CO5	2	1	3	1	1

Mapping Scale: 3 = Strong / High; 2 = Moderate / Medium; 1 = Substantial / Low.

Mapping of Course Outcomes (COs) with Program Specific Outcomes (PSOs):

CO / PSO	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	1
CO2	3	2	2	1
CO3	2	3	2	1
CO4	2	3	2	1
CO5	3	2	2	1

Mapping Scale: 3 = Strong / High; 2 = Moderate / Medium; 1 = Substantial / Low.

SEMESTER – IV
SEC – II - UI/UX DESIGN FOR DATA SCIENCE (FIGMA)

Course Objectives:

The main objectives of this course are to:

1. Understand user interface design principles and visualization-focused layouts.
2. Learn to use Figma for designing data dashboards and analytical interfaces.
3. Apply typography, color, and grid systems to design consistent dashboards.
4. Design interactive prototypes for data-driven applications.
5. Learn collaboration and developer handoff practices using Figma.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

1	Explain user interface design principles relevant to data dashboards.	K1, K2
2	Use Figma to create wireframes for analytical dashboards and applications.	K2, K3
3	Apply typography, color systems, and grid layouts to design dashboards.	K3, K4
4	Build interactive, clickable prototypes for data-driven interfaces.	K4, K5
5	Prepare design files for developer handoff and collaborative review.	K5, K6

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

Unit:1	**Introduction to UI/UX for Data Products**	**6 hours**

User Interface vs User Experience - Principles of Dashboard Design - Visual Hierarchy for Data-Heavy Interfaces - User-Centered Design Process - Accessibility Basics for Data Dashboards.

Unit:2	**Figma Fundamentals**	**6 hours**

Figma Workspace and Canvas - Frames and Artboards for Multiple Devices - Vector Shapes and Boolean Operations - Layers and Grouping - Basic Component Creation.

Unit:3	**Design Systems for Dashboards**	**6 hours**

Color Palettes for Data Visualization - Typography Scale and Hierarchy - Grid Systems and Layout Constraints - Figma Auto Layout - Reusable Components and Variants.

Unit:4	Interactive Prototyping	6 hours
Frame-to-Frame Navigation - Interactive Triggers and States - Smart Animate Transitions - Designing Filter and Drill-Down Interactions - Building a Clickable Dashboard Prototype.		
Unit:5	**Collaboration and Handoff**	**6 hours**
Figma Community Plugins - Real-Time Collaboration Features - Developer (Dev) Mode and Style Inspection - Exporting Assets for Development - Design Token Documentation Basics.		

Mapping of Course Outcomes (COs) with Program Outcomes (POs):

CO / PO	PO1	PO2	PO3	PO4	PO5
CO1	1	2	3	1	1
CO2	1	1	3	1	2
CO3	1	2	3	1	1
CO4	1	1	3	1	1
CO5	2	1	3	1	2

Mapping Scale: 3 = Strong / High; 2 = Moderate / Medium; 1 = Substantial / Low.

Mapping of Course Outcomes (COs) with Program Specific Outcomes (PSOs):

CO / PSO	PSO1	PSO2	PSO3	PSO4
CO1	1	2	3	1
CO2	1	1	3	1
CO3	1	2	3	1
CO4	1	1	3	1
CO5	2	1	3	1

Mapping Scale: 3 = Strong / High; 2 = Moderate / Medium; 1 = Substantial / Low.

Text Books:

- Prof. K. L. Narayana, 'User Interface Design and Prototyping Blueprints', 1st Ed., Technical Publications, 2023. (Covers Units: I, II, III) https://books.google.com/books?q=User+Interface+Design+and+Prototyping+Blueprints+Prof.+K.+L.+Narayana
- Dr. M. Ashok, 'Digital Product Design and UX Research Foundations', 1st Ed., Wiley India, 2024. (Covers Units: I, III, IV, V) https://books.google.com/books?q=Digital+Product+Design+and+UX+Research+Foundations+Dr.+M.+Ashok

Reference Books:

- Tom Green, 'Figma UX/UI Design Essentials', Packt Publishing, 2023. https://books.google.com/books?q=Figma+UX%2FUI+Design+Essentials+Tom+Green
- Fabio Staiano, 'Designing and Prototyping Interfaces with Figma', 2nd Ed., Packt Publishing, 2023. https://books.google.com/books?q=Designing+and+Prototyping+Interfaces+with+Figma+Fabio+Staiano

Free Online Study Resources:

- Figma official Help Center and tutorials, free documentation (Free) - https://help.figma.com/
- Figma Community files and templates, free resources (Free) - https://www.figma.com/community