KSR College of Engineering

NAAC ACCREDITED A++ | NBA ACCREDITED PROGRAMMES

AN AUTONOMOUS INSTITUTION

M.E. - BIG DATA ANALYTICS

Curriculum &
Syllabus for Semester I and II

REGULATIONS 2024

(Academic Year 2024-25 Onwards)

K.S.R. COLLEGE OF ENGINEERING: TIRUCHENGODE - 637 215

(Autonomous)

DEPARTMENT OF COMPUTER SCIENCE AND ENIGNEERING

M.E. – BIG DATA ANALYTICS

(REGULATIONS 2024)

Vision of the Institution

IV	We envision to achieve status as an excellent Educational Institution in the global knowledge hub, making self-learners, experts, ethical and responsible engineers, technologists, scientists, managers, administrators and entrepreneurs who will significantly contribute to research and environment friendly sustainable growth of the nation and the world.

Mission of the Institution

IM1	To inculcate in the students self-learning abilities that enable them to become competitive and considerate engineers, technologists, scientists, managers, administrators and entrepreneurs by diligently imparting the best of education, nurturing environmental and social needs.
IM 2	To foster and maintain mutually beneficial partnership with global industries and Institutions through knowledge sharing, collaborative research and innovation.

Vision of the Department / Programme: (Big Data Analytics)

DV	To create ever green professionals for software industry, academicians for knowledge cultivation and researchers for contemporary society modernization.

Mission of the Department / Programme: (Big Data Analytics)

DM 1	To produce proficient design, code and system engineers for software development.
DM 2	To keep updated contemporary technology and fore coming challenges for welfare of the society.

Programme Educational Objectives (PEOs): (Big Data Analytics)

The graduates of the programme will be able to	
PEO 1	**Engineering knowledge:** Apply the necessary mathematical tools and fundamental & advanced knowledge of computer science & engineering.
PEO 2	**Development of solutions:** Develop computer/software/network systems understanding the importance of social, business, technical, environmental, and human context in which the systems would work.
PEO 3	**Individual and Teamwork:** Contribute effectively as a team member/leader, using common tools and environment, in computer science and engineering projects, research, or education.

Programme Outcomes (POs) of B.E. - Big Data Analytics

PO1	**M.E Big Data Analytics graduates will be able to attain:** An ability to independently carry out research /investigation and development work to solve practical problems.
PO2	An ability to write and present a substantial technical report/document.
PO3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.
PSO1	**Computer System Design:** Apply the knowledge of computer system design principles in building system software and hardware components.
PSO2	**Solve Computational Problems:** Apply the theoretical foundations of computer science in modeling and developing solutions to the real-world problems.

	K. S. R COLLEGE OF ENGINEERING **An Autonomous Institution** **Approved by AICTE and Affiliated to Anna University, Chennai** **Accredited by NAAC ('A++' Grade)**	**Curriculum** **PG** **R - 2024**
Department	**Department of Computer Science and Engineering**	
Programme	**M.E. Big Data Analytics**	

SEMESTER I

S. No.	Course Code	Course Title	Category	Periods / Week				Credit	Max. Marks		
				L	T	P	Tot		CA	ES	Tot
Induction Programme			-	-	-	-	-	-	-	-	-
THEORY COURSES											
1	MA24T16	Operations Research	FC	3	0	0	3	**3**	40	60	100
2	CS24T16	Advanced Data Structures and Algorithms	PCC	3	0	0	3	**3**	40	60	100
3	CS24T17	Database Practices	PCC	3	0	0	3	**3**	40	60	100
4	BD24T16	Foundations of Data Science	PCC	3	0	0	3	**3**	40	60	100
5		Professional Elective - I	PEC	3	0	0	3	**3**	40	60	100
6		Professional Elective - II	PEC	3	0	0	3	**3**	40	60	100
LABORATORY COURSES											
7	CS24P16	Advanced Data Structures and Algorithms Laboratory	PCC	0	0	3	3	**2**	60	40	100
8	BD24P11	Foundations of Data Science Laboratory	PCC	0	0	3	3	**2**	60	40	100
			TOTAL	**18**	**0**	**6**	**24**	**22**	**800**		

SEMESTER II

S. No.	Course Code	Course Title	Category	Periods / Week				Credit	Max. Marks		
				L	T	P	Tot		CA	ES	Tot
THEORY COURSES											
1	RM24T09	Research Methodology and IPR	RMC	3	0	0	3	**3**	40	60	100
2	BD24T26	Big Data Mining and Analytics	PCC	3	0	0	3	**3**	40	60	100
3	CS24T27	Cloud Computing	PCC	3	0	0	3	**3**	40	60	100
4	BD24T27	Machine Learning Techniques	PCC	3	0	0	3	**3**	40	60	100
5		Professional Elective - III	PEC	3	0	0	3	**3**	40	60	100
6		Professional Elective - IV	PEC	3	0	0	3	**3**	40	60	100
LABORATORY COURSES											
7	BD24P26	Big Data Mining and Analytics Laboratory	PCC	0	0	3	3	**2**	60	40	100
8	CS24P26	Cloud Computing Laboratory	PCC	0	0	3	3	**2**	60	40	100
9	BD24P21	Technical Presentation	EEC	0	0	3	3	**2**	60	40	100
			TOTAL	**18**	**0**	**9**	**27**	**24**	**900**		

SEMESTER III											
S. No.	**Course Code**	**Course Title**	**Category**	**Periods / Week**				**Credit**	**Max. Marks**		
				L	**T**	**P**	**Tot**		**CA**	**ES**	**Tot**
THEORY COURSES											
1	BD24T31	Big Data Security	PCC	3	0	0	3	**3**	40	60	100
2	BD24T32	Information Storage Management	PCC	3	0	0	3	**3**	40	60	100
3		Professional Elective - V	PEC	3	0	0	3	**3**	40	60	100
4		Professional Elective - VI	PEC	3	0	0	3	**3**	40	60	100
5		Audit courses	AC	2	0	0	2	**0**	100	-	100
LABORATORY COURSES											
6	BD24P31	Project Phase – I	EEC	0	0	12	12	**6**	60	40	100
TOTAL				**14**	**0**	**12**	26	**18**	**600**		
SEMESTER IV											
S. No.	**Course Code**	**Course Title**	**Category**	**Periods / Week**				**Credit**	**Max. Marks**		
				L	**T**	**P**	**Tot**		**CA**	**ES**	**Tot**
LABORATORY COURSES											
1	BD24P41	Project Phase – II	EEC	0	0	24	24	**12**	60	40	100
TOTAL				**0**	**0**	**24**	**24**	**12**	**100**		
TOTAL CREDITS								**76**			

TOTAL NUMBER OF CREDITS TO BE EARNED FOR AWARD OF THE DEGREE = 76

Note: FC - Foundation Courses, PCC - Professional Core Courses, RMC – Research Methodology Courses, PEC - Professional Elective courses, EEC - Employability Enhancement Courses and AC - Audit Courses.

FOUNDATION COURSES (FC)											
S. No.	**Course Code**	**Course Title**	**Semester**	**Periods / Week**				**Credit**	**Max. Marks**		
				L	**T**	**P**	**Tot**		**CA**	**ES**	**Tot**
1	MA24T16	Operations Research	I	3	0	0	3	**3**	40	60	100
TOTAL				**3**	**0**	**0**	**3**	**3**			
PROFESSIONAL CORE COURSES (PCC)											
S. No.	**Course Code**	**Course Title**	**Semester**	**Periods / Week**				**Credit**	**Max. Marks**		
				L	**T**	**P**	**Tot**		**CA**	**ES**	**Tot**
1	CS24T16	Advanced Data Structures and Algorithms	I	3	0	0	3	**3**	40	60	100
2	CS24T17	Database Practices	I	3	0	0	3	**3**	40	60	100
3	BD24T16	Foundations of Data Science	I	3	0	0	3	**3**	40	60	100

4	CS24P16	Advanced Data Structures and Algorithms Laboratory	I	0	0	3	3	**2**	60	40	100
5	BD24P11	Foundations of Data Science Laboratory	I	0	0	3	3	**2**	60	40	100
6	BD24T26	Big Data Mining and Analytics	II	3	0	0	3	**3**	40	60	100
7	CS24T27	Cloud Computing	II	3	0	0	3	**3**	40	60	100
8	BD24T27	Machine Learning Techniques	II	3	0	0	3	**3**	40	60	100
9	BD24P26	Big Data Mining and Analytics Laboratory	II	0	0	3	3	**2**	60	40	100
10	CS24P26	Cloud Computing Laboratory	II	0	0	3	3	**2**	60	40	100
11	BD24T31	Big Data Security	III	3	0	0	3	**3**	40	60	100
12	BD24T32	Information Storage Management	III	3	0	0	3	**3**	40	60	100
TOTAL				**24**	**0**	**12**	**36**	**32**			

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S. No.	Course Code	Course Title	Semester	Periods / Week				Credit	Max. Marks		
				L	T	P	Tot		CA	ES	Tot
1	BD24P21	Technical Presentation	II	0	0	3	3	**2**	60	40	100
2	BD24P31	Project Phase – I	III	0	0	12	12	**6**	60	40	100
3	BD24P41	Project Phase – II	IV	0	0	24	24	**12**	60	40	100
TOTAL				**0**	**0**	**39**	**39**	**20**			

RESEARCH METHODOLOGY COURSES(REC)

S. No.	Course Code	Course Title	Semester	Periods / Week				Credit	Max. Marks		
				L	T	P	Tot		CA	ES	Tot
1	RM24T09	Research Methodology and IPR	II	3	0	0	3	**3**	40	60	100
TOTAL				**3**	**0**	**0**	**3**	**3**			

PROFESSIONAL ELECTIVE COURSES (PEC)
PROFESSIONAL ELECTIVES – I and II (SEMESTER – I)

S. No.	Course Code	Course Title	Semester	Periods / Week				Credit	Max. Marks		
				L	T	P	Tot		CA	ES	Tot
1	BD24E01	Embedded Systems and IIOT	I	3	0	0	3	**3**	40	60	100
2	BD24E02	Statistics for Business Analytics	I	3	0	0	3	**3**	40	60	100
3	CS24E04	Object Oriented Software Engineering	I	3	0	0	3	**3**	40	60	100
4	BD24E03	Data Visualization Techniques	I	3	0	0	3	**3**	40	60	100
5	BD24E04	Agile Methodologies	I	3	0	0	3	**3**	40	60	100

6	CS24E06	Multicore Architectures	I	3	0	0	3	**3**	40	60	100
7	BD24E05	Web Services and API Design	I	3	0	0	3	**3**	40	60	100
8	BD24E06	High Performance Computing for Big Data	I	3	0	0	3	**3**	40	60	100
9	CS24T18	Network technologies	I	3	0	0	3	**3**	40	60	100
10	BD24E07	Data Intensive Computing	I	3	0	0	3	**3**	40	60	100

PROFESSIONAL ELECTIVE COURSES (PEC)
PROFESSIONAL ELECTIVES – III and IV (SEMESTER – II)

S. No.	Course Code	Course Title	Semester	Periods / Week				Credit	Max. Marks		
				L	T	P	Tot		CA	ES	Tot
1	BD24E08	Internet of Things	II	3	0	0	3	**3**	40	60	100
2	CS24E09	Full Stack Web Application Development	II	3	0	0	3	**3**	40	60	100
3	CS24E10	Deep learning	II	3	0	0	3	**3**	40	60	100
4	BD24E09	Blockchain Technologies	II	3	0	0	3	**3**	40	60	100
5	CS24E11	Natural Language Processing	II	3	0	0	3	**3**	40	60	100
6	BD24E10	Cyber Physical Systems	II	3	0	0	3	**3**	40	60	100
7	BD24E11	Image and Video Analytics	II	3	0	0	3	**3**	40	60	100
8	CS24E13	Quantum Computing	II	3	0	0	3	**3**	40	60	100
9	BD24E12	Information Retrieval Techniques	II	3	0	0	3	**3**	40	60	100
10	BD24E13	Web Analytics	II	3	0	0	3	**3**	40	60	100

PROFESSIONAL ELECTIVE COURSES (PEC)
PROFESSIONAL ELECTIVES – V (SEMESTER – III)

S. No.	Course Code	Course Title	Semester	Periods / Week				Credit	Max. Marks		
				L	T	P	Tot		CA	ES	Tot
1	BD24E14	DevOps and Microservices	III	3	0	0	3	**3**	40	60	100
2	CS24T36	Soft Computing	III	3	0	0	3	**3**	40	60	100
3	BD24E15	Healthcare Analytics	III	3	0	0	3	**3**	40	60	100
4	BD24E16	Predictive Modeling	II	3	0	0	3	**3**	40	60	100
5	BD24E17	Social Network Analysis	III	3	0	0	3	**3**	40	60	100

OPEN ELECTIVE OFFERED BY OTHER DEPARTMENT

1	CS24O03	Multimedia Technologies	III	3	0	0	3	**3**	40	60	100
2	PE24O03	Renewable Energy Technology	III	3	0	0	3	**3**	40	60	100
3	ET24O01	Embedded Systems	III	3	0	0	3	**3**	40	60	100
4	CN24O03	Stress management	III	3	0	0	3	**3**	40	60	100

5	ST24O01	Principles of Sustainable development	III	3	0	0	3	**3**	40	60	100
6	CU24O01	Principles of Multimedia	III	3	0	0	3	**3**	40	60	100
7	IS24O01	Industrial Safety Engineering	III	3	0	0	3	**3**	40	60	100
8	IS24O03	Food and Bio-safety	III	3	0	0	3	**3**	40	60	100
OPEN ELECTIVE OFFERED TO OTHER DEPARTMENT											
9	BD24O01	Big Data Analytics	III	3	0	0	3	**3**	40	60	100
10	BD24O02	Internet of Things and Cloud	III	3	0	0	3	**3**	40	60	100
11	BD24O03	Big Data Visualization	III	3	0	0	3	**3**	40	60	100

AUDIT COURSES (SEMESTER – III)

S. No.	Course Code	Course Title	Semester	Periods / Week				Credit	Max. Marks		
				L	T	P	Tot		CA	ES	Tot
1	BD24A01	Disaster Management	III	2	0	0	2	**0**	100	-	100
2	BD24A02	Value Education	III	2	0	0	2	**0**	100	-	100
3	BD24A03	Constitution of India	III	2	0	0	2	**0**	100	-	100
4	BD24A04	Indian Knowledge System	III	2	0	0	2	**0**	100	-	100

Summary

Name of the Programme: M.E Big Data Analytics

CATEGORY	I	II	III	IV	TOTAL CREDITS	%
FC	3	-	-	-	**3**	**3.94**
PCC	13	13	6	-	**32**	**42.10**
REC	-	3	-	-	**3**	**3.94**
PEC	6	6	3	-	**15**	**19.73**
OEC	-	-	3	-	**3**	**3.94**
EEC	-	2	6	12	**20**	**26.31**
AC	-	-	✓	-	**-**	**-**
Total	**22**	**24**	**18**	**12**	**76**	**100**

MA24T16	OPERATIONS RESEARCH	Category	L	T	P	C
		FC	3	0	0	3

(Common to M. E CSE, M. E BDA and M.Tech IT)

PREREQUISITE

For Effective learning and applying resource management technique students must have a foundational understanding of optimization technique like linear programming and integer programming, basic knowledge of network programming, Queuing model.

OBJECTIVES:

1. To determine the most effective way to allocate the best value of linear programming such as profit or loss based on decision variables.
2. To analyze the most effective way to minimize the total transportation cost and to find the optimal way to assign a set of tasks.
3. To determine the optimal quantity of inventory to hold the balancing between excess and shortage and improve optimal efficiency and reduce waste.
4. To develop the ability to analyze the basic components and behavior of queuing systems
5. To facilitate learners about the PERT/CPM models to identify shortest path, Network design, Project Scheduling.

UNIT – I	LINEAR PROGRAMMING	(9)

Formation of LPP – Graphical method – Simplex method – Big M Method – Dual simplex method.

UNIT – II	TRANSPORTATION AND ASSIGNMENT PROBLEMS	(9)

Transportation Models (Minimizing and Maximizing Problems) – Balanced and unbalanced Problems – Initial Basic feasible solution by North West Corner Rule, least cost and Vogel's approximation methods – Optimum solution by MODI Method – Assignment Models (Minimizing and Maximizing Problems) – Hungarian method - Balanced and Unbalanced Problems.

UNIT – III	INVENTORY MODELS	(9)

Types of Inventory – Deterministic inventory models: Purchasing problem with no shortage and with shortages – Production problem with and without shortages – Purchase problem with price breaks – Probabilistic inventory model (excluding proof).

UNIT – IV	QUEUING MODELS	(9)

Characteristics of Queuing Models – Kendall's notations - Little's formula – (M/M/1): (∞/FIFO) Single Server with infinite capacity – (M/M/C):(∞/FIFO) Multi Server with infinite capacity – (M/M/1) : (N/FIFO) Single Server with finite capacity – (M/M/C) : (N/FIFO) Multi server with finite capacity

UNIT – V	PERT/CPM	(9)

Network Construction – Critical Path Method – Computation of earliest start time, latest start time, Total, free and independent float time – PERT Analysis – Computation of optimistic, most likely Pessimistic and expected time.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, the students will be able to:

COs	Course Outcome	Cognitive Level
CO1	Apply the concepts of linear programming approach during the uncertain situations.	Apply
CO2	Analyze the transportation method and Assignment method to minimize costs	Analyze
CO3	Evaluate the inventory model using EOQ and EBQ with and without shortage.	Apply
CO4	Analyze and interpret the key features of various queuing systems	Analyze
CO5	Apply and evaluate the concepts of network model	Analyze

TEXT BOOKS:

1. Taha H.A, "Operation Research", Pearson Education, Noida , 9th Edition, 2013
2. Vohra N D, "Quantitative Techniques in Management", Tata Mc Graw Hill, New Delhi, 6th Edition, 2021.

REFERENCES:

1. P.K. Gupta and Man Mohan, "Problems in Operations Research", S. Chand and Co, New Delhi, 12th Edition, 2014
2. Wayne. L. Winston, "Operations research applications and algorithms", Thomson learning, United States, 4th Edition,2016.
3. Kalavathy S, "Operations Research", Vikas Publishing House, Ahmedabad, 6th Edition, 2019.
4. Hira and Gupta, "Problems in Operations Research", S. Chand and Co, New Delhi, 2nd Edition, 2012.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	-	-	2	-
CO2	3	-	-	2	-
CO3	3	-	-	2	-
CO4	3	-	-	2	-
CO5	3	-	-	2	-
Avg.	**3**	**-**	**-**	**2**	**-**

1-low, 2-medium, 3-high

CS24T16	ADVANCED DATA STRUCTURES AND ALGORITHMS	Category	L	T	P	C
		PCC	3	0	0	3

(Common to M.E CSE and M.E BDA)

PREREQUISITE
Familiarity with basic data structures like arrays, linked lists, stacks, and queues is essential for understanding advanced topics. This foundational knowledge helps in grasping how more complex data structures and algorithms build upon these basics to address intricate problems.

OBJECTIVES:

6. To introduce the fundamental concepts of algorithm efficiency and complexity analysis.
7. To explore advanced tree and heap data structures for efficient data management
8. To teach graph algorithms for traversal, shortest paths, and minimum spanning trees.
9. To learn the skills in applying dynamic programming and greedy strategies for optimization.
10. To study the principles of NP-completeness, NP-hardness, and approximation algorithms.

UNIT – I	ROLE OF ALGORITHMS IN COMPUTING	(9)

Algorithms – Algorithms as a Technology – Time and Space complexity of algorithms – Asymptotic analysis – Average and Worst-case analysis – Asymptotic notation – Importance of efficient algorithms – Program performance measurement – Recurrences: The Substitution Method – The Recursion– Tree Method.

UNIT – II	HIERARCHICAL DATA STRUCTURES	(9)

Binary Search Trees – Red Black trees – B-Trees – B+ Trees – AVL Tree – Multi-way Search Trees – Heap: Heap Operations – Min/Max heaps – Fibonacci Heaps: Structure – Mergeable-heap operations– Decreasing a key and deleting a node– Bounding the maximum degree.

UNIT – III	GRAPH	(9)

Graph: Representations of Graphs – Breadth-First Search – Depth-First Search – Topological Sort – Minimum Spanning Trees: Growing a Minimum Spanning Tree – Kruskal and Prim's – Single-Source Shortest Paths: The Bellman-Ford algorithm – Dijkstra's Algorithm – All-Pairs Shortest Paths: Shortest Paths and Matrix Multiplication – The Floyd -Warshall Algorithm.

UNIT – IV	ALGORITHM DESIGN TECHNIQUES	(9)

Dynamic Programming: Matrix-Chain Multiplication – Optimal binary search trees – Elements of Dynamic Programming – Longest Common Subsequence – Greedy Algorithms: An Activity – Selection Problem – Elements of the Greedy Strategy – Huffman Codes and Trees.

UNIT – V	NP COMPLETE AND NP HARD	(9)

NP Completeness: Polynomial Time – Polynomial Time Verification – NP Completeness and Reducibility – Proof of NP hardness and NP completeness – Approximation algorithms – Randomized Algorithms.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, the students will be able to:

COs	Course Outcome	Cognitive Level
CO1	Comprehend fundamental concepts of algorithm efficiency and apply complexity analysis methods.	**Understand**
CO2	Recognize and implement advanced hierarchical data structures for effective data management.	**Understand**
CO3	Apply graph algorithms to solve shortest paths and spanning trees and analyze their results.	**Apply**
CO4	Identify dynamic programming and greedy strategies and synthesize these techniques for optimization.	**Understand**
CO5	Analyze NP-complete problems and develop solutions using approximation and randomized algorithms.	**Apply**

REFERENCES:

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, "Introduction to Algorithms", MIT Press, London, 4 th Edition, 2022.
2. Reema Thareja, "Data Structures Using C", Oxford University Press, England, 3rd Edition, 2023.
3. Weiss, "Data Structures and Algorithm Analysis in C", Pearson Education, India, 2nd Edition, 2015.
4. Alfred V. Aho, John E. Hopcroft, Jeffrey D. Ullman, "Data Structures and Algorithms", Pearson Education, India, Reprint 2006.
5. S.Sridhar, "Design and Analysis of Algorithms", Oxford University Press, England, 1st Edition, 2014.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	-	3	1	3
CO2	3	-	3	1	3
CO3	3	-	3	1	3
CO4	3	-	3	1	3
CO5	3	-	3	1	3
Avg.	**3**	**-**	**3**	**1**	**3**

1-low, 2-medium, 3-high

CS24T17	DATABASE PRACTICES	Category	L	T	P	C
		PCC	3	0	0	3

(Common to M.E CSE and M.E BDA)

PREREQUISITE
Students should have a foundation in SQL, relational algebra and basic database design principles. Knowledge of distributed databases, XML, and introductory NoSQL systems is also needed.

OBJECTIVES:
1. To explore fundamental concepts of the relational model and SQL.
2. To learn database design strategies using E-R modelling and normalization.
3. To study distributed databases, active databases, and open database connectivity.
4. To know XML data models and management methods within databases.
5. To examine NoSQL databases and big data storage technologies like Hadoop and Map Reduce.

UNIT – I	RELATIONAL DATA MODEL	(9)

Introduction to the Relational Model – Relational Algebra – Introduction to SQL – Intermediate SQL – Advanced SQL.

UNIT – II	DATABASE DESIGN	(9)

Database Design Using the E-R Model: Overview of the Design Process – The Entity-Relationship Model – Complex Attributes – Mapping Cardinalities – Removing Redundant Attributes in Entity Sets – Reducing E-R Diagrams to Relational Schemas – Extended E-R Features – Entity-Relationship Design Issues – Alternative Notations for Modeling Data – Relational Database Design: Features of Good Relational Designs – Functional Dependencies – Non-loss Decomposition – First, Second and Third Normal Forms, Dependency Preservation – Boyce/Codd Normal Form – Multi-valued Dependencies and Fourth Normal Form – Join Dependencies and Fifth Normal Form.

UNIT – III	DISTRIBUTED DATABASES, ACTIVE DATABASES AND OPEN DATABASE CONNECTIVITY	(9)

Distributed Database Architecture – Distributed Data Storage – Distributed Query Processing – Distributed Transaction Processing – Active Database Concepts and Triggers – Design and Implementation Issues for Active Databases – Open Database Connectivity.

UNIT – IV	XML DATABASES	(9)

Structured, Semi structured and Unstructured Data – XML Hierarchical Data Model – XML Documents – Document Type Definition – XML Schema – Storing and Extracting XML Documents from Databases – XML Languages – Extracting XML Documents from Relational Databases – XML/SQL: SQL Functions for Creating XML Data.

UNIT – V	NOSQL DATABASES AND BIG DATA STORAGE SYSTEMS	(9)

Introduction to NOSQL Systems – CAP Theorem – Document-Based NoSQL Systems and MongoDB – NoSQL Key-Value Stores – DynamoDB Overview – Voldemort Key-Value Distributed Data Store – Column-Based or Wide Column NoSQL Systems – NoSQL Graph Databases and Neo4j – Big Data – MapReduce – Hadoop – YARN.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, the students will be able to:

COs	Course Outcome	Cognitive Level
CO1	Interpret and utilize the principles of the relational model and SQL effectively.	**Understand**
CO2	Comprehend and apply E-R modeling and normalization.	**Apply**
CO3	Familiarize with and analyze distributed and active databases and connectivity.	**Understand**
CO4	Recognize XML data models and apply XML management methods.	**Apply**
CO5	Examine NoSQL databases and evaluate big data technologies.	**Apply**

REFERENCES:

1. Abraham Silberschatz, Henry F. Korth and S. Sudharshan, "Database System Concepts", Tata McGraw Hill, New Delhi, 7th Edition, 2019.
2. Ramez Elmasri and Shamkant B. Navathe, "Fundamentals of Database Systems", Pearson Education, New Delhi, 7th Edition, 2016.
3. S.K.Singh, "Database Systems Concepts, Design and Applications", Pearson Education, New Delhi, 2nd Edition, 2011.
4. Harrison, Guy, "Next Generation Databases, NoSQL and Big Data", Apress publishers, Pune, 1st Edition, 2015.
5. Thomas Cannolly and Carolyn Begg, "Database Systems, A Practical Approach to Design, Implementation and Management", Pearson Education, New Delhi, 6th Edition, 2015.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	-	1	3	1
CO2	3	-	1	3	1
CO3	3	-	1	3	1
CO4	3	-	1	3	1
CO5	3		1	3	1
Avg.	**3**	**-**	**1**	**3**	**1**

1-low, 2-medium, 3-high

BD24T16	FOUNDATIONS OF DATA SCIENCE	Category	L	T	P	C
		PEC	3	0	0	3

(Common to M.E CSE and M.E BDA)

PREREQUISITE

To succeed in a Foundations of Data Science course, students should have basic programming skills in languages like Python or R, a foundational understanding of statistics and mathematics (including linear algebra and calculus), and familiarity with data manipulation and databases.

OBJECTIVES:

1. To introduce data science fundamentals and processes.
2. To study methods for statistical description and analysis of data.
3. To explore correlation and regression techniques.
4. To learn data manipulation using Python libraries.
5. To develop skills in creating and customizing data visualizations using Python tools.

UNIT – I	BASICS OF DATA SCIENCE	(9)

Data Science: Benefits and uses – Facets of data – Data Science Process: Overview – Defining research goals – Retrieving data – Data preparation – Exploratory Data analysis – Build the model – Presenting findings and building applications – Data Mining – Data Warehousing – Basic Statistical descriptions of Data.

UNIT – II	DESCRIBING DATA	(9)

Types of Data – Types of Variables – Describing Data with Tables and Graphs – Describing Data with Averages Variability – Normal Distributions and Standard (z) Scores.

UNIT– III	DESCRIBING RELATIONSHIP	(9)

Correlation – Scatter plots – Correlation coefficient for quantitative data – Computational formula for correlation coefficient – Regression – Regression line – Least squares regression line – Standard error of estimate – Interpretation of r2 – Multiple regression equations – Regression towards the mean.

UNIT – IV	PYTHON LIBRARIES FOR DATA WRANGLING	(9)

Basics of Numpy arrays – Aggregations – Computations on arrays – Comparisons, Masks, Boolean logic – Fancy indexing – Structured arrays – Data manipulation with Pandas – Data indexing and selection – Operating on data – Missing data – Hierarchical indexing – Combining datasets – Aggregation and Grouping – Pivot tables.

UNIT – V	DATA VISUALIZATION	(9)

Importing Matplotlib – Line plots – Scatter plots – Visualizing errors – Density and contour plots – Histograms – Legends – Colors – Subplots – Text and Annotation – Customization – Three-Dimensional plotting – Geographic Data with Basemap – Visualization with Seaborn.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, the students will be able to:

COs	Course Outcome	Cognitive Level
CO1	Enlighten data science fundamentals and processes.	**Understand**
CO2	Summarize data using statistical methods.	**Understand**
CO3	Apply and interpret correlation3 and regression techniques.	**Apply**
CO4	Manipulate data using Python libraries.	**Apply**
CO5	Analyze and customize data visualizations in Python.	**Analyze**

REFERENCES:

1. David Cielen, Arno D. B. Meysman, and Mohamed Ali, "Introducing Data Science", Manning Publications, New Yark, 1st Edition, 2016.
2. Robert S. Witte and John S. Witte, "Statistics", Wiley Publications, India, 11th Edition, 2021.
3. Jake VanderPlas, "Python Data Science Handbook", O'Reilly, US, 1st Edition, 2016.
4. Allen B. Downey, "Think Stats: Exploratory Data Analysis in Python", Green Tea Press, India, 2nd Edition, 2016.
5. Sinan Ozdemir, "Principles of Data Science", Packt Publication, UK, 3rd Edition, 2024.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PSO1	PSO2
CO1	1	1	3	3	2
CO2	1	1	3	3	2
CO3	1	1	3	3	2
CO4	1	1	3	3	2
CO5	1	1	3	3	2
Avg.	**1**	**1**	**3**	**3**	**2**

1-low, 2-medium, 3-high

CS24P16	ADVANCED DATA STRUCTURES AND ALGORITHMS LABORATORY	Category	L	T	P	C
		PCC	0	0	3	2

(Common to M.E CSE and M.E BDA)

PREREQUISITE

Students should have a basic understanding of programming, data structures and fundamental algorithms. Familiarity with mathematical concepts related to recursion and algorithm complexity, along with strong problem-solving skills

OBJECTIVES:

1. To gain proficiency in developing and applying recursive functions for various computational problems.
2. To achieve competence in implementing and evaluating different sorting algorithms for effective data management.
3. To acquire skills in creating and managing various tree data structures for efficient data organization and retrieval.
4. To become adept at applying algorithms for solving graph-related problems, such as finding shortest paths and constructing minimum spanning trees.
5. To develop the ability to implement and analyze algorithms for complex optimization problems and coding challenges.

List of Exercise/Experiments:

1. Develop recursive methods for tree traversal (In-order, Pre-order, Post-order) and for calculating Fibonacci numbers.
2. Generate solutions for Merge Sort and Quick Sort algorithms.
3. Construct a Binary Search Tree (BST) with essential operations like insertion, deletion, and search.
4. Design and build a Red-Black Tree, ensuring it maintains its balancing properties.
5. Construct a Heap (Min-Heap or Max-Heap) and perform standard heap operations.
6. Assemble a Fibonacci Heap and utilize it for efficient priority queue operations.
7. Develop Prim’s algorithm to determine the Minimum Spanning Tree of a graph.
8. Implementation of minimum cost spanning tree using Kruskal’s algorithm.
9. Design Dijkstra's algorithm and Bellman-Ford algorithm to compute the shortest paths from a single source in a graph.
10. Write a program to compute the shortest path from a single source to all other vertices in a given graph.
11. Develop an algorithm to solve the Matrix Chain Multiplication problem, optimizing the sequence of matrix multiplications.
12. Design the Activity Selection problem using a greedy strategy and Huffman Coding Implementation.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, the students will be able to:

COs	Course Outcome	Cognitive Level
CO1	Develop and execute recursive algorithms for problem-solving tasks.	**Apply**
CO2	Apply and compare sorting techniques to evaluate their performance and efficiency.	**Apply**
CO3	Build and work with various tree structures to organize and access data effectively.	**Apply**
CO4	Implement graph algorithms to solve problems related to shortest paths and minimum spanning trees.	**Apply**
CO5	Develop and apply algorithms for complex optimization and coding challenges.	**Apply**

REFERENCES:

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, "Introduction to Algorithms", MIT Press, London, 4 th Edition, 2022.
2. Reema Thareja, "Data Structures Using C", Oxford University Press, England, 3 rd Edition, 2023.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PSO1	PSO2
CO1	**3**	**-**	**3**	**3**	**2**
CO2	**3**	**-**	**3**	**3**	**2**
CO3	**3**	**-**	**3**	**3**	**2**
CO4	**3**	**-**	**3**	**3**	**2**
CO5	**3**	**-**	**3**	**3**	**2**
Avg.	**3**	**-**	**3**	**3**	**2**

1-low, 2-medium, 3-high

BD24P11	FOUNDATIONS OF DATA SCIENCE LABORATORY	Category	L	T	P	C
		PCC	0	0	3	2

PREREQUISITE

Students should have basic Python programming skills, knowledge of data handling and statistics, and experience with data visualization techniques. Familiarity with installing and configuring software packages is also necessary.

OBJECTIVES:

1. To install and familiarize with NumPy, SciPy, Jupyter, Statsmodels, and Pandas.
2. To handle and manipulate NumPy arrays and Panda's data frames.
3. To conduct descriptive and inferential analysis on Iris, diabetes, and Pima Indians datasets.
4. To create various plots including histograms, scatter plots, and 3D plots for data insights.
5. To use Basemap for visualizing and analyzing geographic data.

List of Exercise/Experiments:

1. Download, install and explore the features of NumPy, SciPy, Jupyter, Statsmodels and Pandas packages.
2. Working with Numpy arrays
3. Working with Pandas data frames
4. Reading data from text files, Excel and the web and exploring various commands for doing descriptive analytics on the Iris data set.
5. Use the diabetes data set from UCI and Pima Indians Diabetes data set for performing the following:
    a. Univariate analysis: Frequency, Mean, Median, Mode, Variance, Standard Deviation, Skewness and Kurtosis.
    b. Bivariate analysis: Linear and logistic regression modeling
    c. Multiple Regression analysis
    d. Also compare the results of the above analysis for the two data sets.
6. Apply and explore various plotting functions on UCI data sets.
    a. Normal curves
    b. Density and contour plots
    c. Correlation and scatter plots
    d. Histograms
    e. Three-dimensional plotting
7. Visualizing Geographic Data with Basemap

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, the students will be able to:

COs	Course Outcome	Cognitive Level
CO1	Demonstrate proficiency in installing and exploring features of NumPy, SciPy, Jupyter, Stats models, and Pandas.	**Apply**
CO2	Effectively work with NumPy arrays and Pandas data frames for data processing and analysis.	**Apply**
CO3	Perform univariate, bivariate, and multiple regression analyses on provided datasets, and compare results.	**Apply**
CO4	Generate and interpret various plots, such as normal curves, density plots, and 3D plots, to visualize data trends and patterns.	**Apply**
CO5	Utilize Basemap to visualize and analyze geographic data, enhancing spatial data interpretation.	**Apply**

REFERENCES:

1. David Cielen, Arno D. B. Meysman, and Mohamed Ali, "Introducing Data Science", Manning Publications, New Yark, First Edition, 2016.
2. Robert S. Witte and John S. Witte, "Statistics", Wiley Publications, India, Eleventh Edition, 2021.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PSO1	PSO2
CO1	**3**	**1**	**2**	**1**	**3**
CO2	**3**	**1**	**2**	**1**	**3**
CO3	**3**	**1**	**2**	**1**	**3**
CO4	**3**	**1**	**2**	**1**	**3**
CO5	**3**	**1**	**2**	**1**	**3**
Avg.	**3**	**1**	**2**	**1**	**3**

1-low, 2-medium, 3-high

RM24T09	RESEARCH METHODOLOGY AND IPR	Category	L	T	P	C
		RMC	3	0	0	3

(Common to PED, EST, CSE, BDA, CAD CAM, ISE)

PREREQUISITE: A basic understanding of academic writing and critical thinking skills to analyze research literature, familiarity with fundamental statistical concepts for data analysis, and a strong grasp of core subject knowledge relevant to the student's field. Additionally, a general awareness of legal principles related to intellectual property, ethical research practices, and innovation trends will enhance the student's ability to engage with both research methodologies and IPR concepts.

OBJECTIVES:

- To equip students with the ability to design and conduct rigorous research, employing appropriate methodologies, and critically analyzing results.
- To foster the ability to critically evaluate academic literature, identify research gaps, and formulate research questions.
- To enable students to effectively communicate research findings and legal arguments, both in written form and through presentations, to academic and professional audiences.
- To instill an understanding of ethical issues in research, including responsible conduct, data integrity, and the ethical use of intellectual property.
- To provide a comprehensive understanding of intellectual property rights, including patents, trademarks, copyrights, and their application in various industries.

UNIT - I	RESEARCH DESIGN	(9)

Overview of research process and design – Use of Secondary and exploratory data to answer the research question, Qualitative research, Observation studies – Experiments and surveys.

UNIT - II	DATA COLLECTION AND SOURCES	(9)

Measurements: Measurement Scales – Questionnaires and Instruments – Sampling and Methods. Data - Preparing, Exploring, Examining and displaying.

UNIT - III	DATA ANALYSIS AND REPORTING	(9)

Overview of Multivariate analysis – Hypotheses testing and Measures of Association – Presenting Insights and findings using written reports and oral presentation.

UNIT - IV	INTELLECTUAL PROPERTY RIGHTS	(9)

Intellectual Property – The concept of IPR, Evolution and development of the concept of IPR, IPR development process, Trade secrets, utility Models, IPR & Biodiversity, Role of WIPO and WTO in IPR establishments, Right of Property, Common rules of IPR practices, Types and Features of IPR Agreement, Trademark, Functions of UNESCO in IPR maintenance.

UNIT - V	PATENTS	(9)

Patents – objectives and benefits of patent – Concept, features of patent, Inventive step, Specification – Types of patent application, process E-filling – Examination of patent – Grant of patent, Revocation, Equitable Assignments. Licenses – Licensing of related patents – patent agents, – Registration of patent agents.

TOTAL: 45 PERIODS

COURSE OUTCOMES:		
At the end of the course, the students will be able to:		
COs	**Course Outcome**	**Cognitive Level**
CO1:	Develop a suitable research process to solve real-time problems.	Apply
CO2:	Apply appropriate methods to collect qualitative and quantitative data for analysis.	Apply
CO3:	Apply appropriate statistical tools to analyze data and solve research problems.	Apply
CO4:	Describe the types and features of intellectual property and its role in IPR establishment.	Apply
CO5:	Illustrate the patent procedures, E-filling, register of patents, and licensing of patents.	Apply

TEXT BOOKS:	
1	Cooper Donald, R., Schindler Pamela, S., and Sharma, J.K., "Business Research Methods", Tata McGraw Hill Education, Eleventh Edition, 2012.
2	Catherine J. Holland, Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets, Entrepreneur Press, 2007.
REFERENCES:	
1	David Hunt, Long Nguyen, Matthew Rodgers, Patent Searching: Tools & Techniques, Wiley, 2007.
2	The Institute of Company Secretaries of India, Statutory body under an Act of Parliament, Professional Programme Intellectual Property Rights, Law and Practice, September 2013.

Mapping of COs with POs and PSOs

COs/ POs	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**
CO1	3	3	-	1	1
CO2	3	3	-	1	1
CO3	3	3	-	1	1
CO4	3	3	-	1	1
CO5	3	3	-	1	1
Avg.	3	3	-	1	1

1 - Low, 2 - Medium, 3 - High

BD24T26	BIG DATA MINING AND ANALYTICS	Category	L	T	P	C
		PCC	3	0	0	3

(Common to M.E CSE and M.E BDA)

PREREQUISITE

Basic knowledge of data processing, statistical modeling, and machine learning is required. Familiarity with clustering algorithms and Hadoop is also helpful. Understanding data stream processing and analytics tools will aid in comprehension.

OBJECTIVES

1. To explore statistical modeling, machine learning, and MapReduce for large-scale data.
2. To learn data stream processing techniques such as sampling and filtering.
3. To study and apply various clustering techniques like partitioning and hierarchical methods.
4. To gain practical knowledge of Hadoop's file system and ecosystem for big data management.
5. To master big data analytics and integrate unstructured with structured data.

UNIT – I	LARGE SCALE FILES AND MAPREDUCE	(9)

Statistical Modeling – Machine Learning – Computational Approaches to Modeling – Summarization – Feature Extraction – Statistical Limits on Data Mining – Distributed File Systems – MapReduce – Algorithms Using MapReduce – Extensions to MapReduce.

UNIT – II	MINING DATA STREAMS	(9)

Stream Data Model – Sampling Data in a Stream – Filtering Streams – Counting Distinct Elements in a Stream – Estimating Moments – Counting Ones in a Window – Decaying Windows.

UNIT – III	CLUSTER ANALYSIS AND METHODS	(9)

Cluster Analysis – Partitioning Methods – Hierarchical Methods – Density-Based Methods – Grid-Based Methods – Evaluation of Clustering.

UNIT – IV	HADOOP AND ITS ECOSYSTEM	(9)

Explaining Hadoop – Hadoop Distributed File System – Hadoop MapReduce – Building Hadoop Ecosystem – Managing Resources and Applications with Hadoop YARN – Storing Big Data with HBase – Mining Big Data with Hive.

UNIT – V	ANALYTICS AND BIG DATA	(9)

Defining Big Data Analytics – Exploring Unstructured data – Understanding Text Analytics – Analysis and Extraction Techniques – Putting results together with structured data – Putting Big data to use – Text Analytics tools for Big Data.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, the students will be able to:

COs	Course Outcome	Cognitive Level
CO1	Apply statistical modeling, machine learning and MapReduce for large-scale data processing.	**Apply**
CO2	Evaluate stream processing techniques and assess their real-time effectiveness.	**Understand**
CO3	Compare various clustering methods and develop effective models using partitioning, hierarchical, and density-based techniques.	**Analyze**
CO4	Utilize Hadoop's file system and tools, and manage big data with Hadoop YARN.	**Apply**
CO5	Analyze and integrate unstructured and structured data, and apply text analytics tools for insights.	**Analyze**

REFERENCES:

1. Jure Leskovec, Anand Rajaraman, Jeffrey David Ullman, "Mining of Massive Datasets", Cambridge University Press, UK, 3rd Edition, 2020.
2. Jiawei Han, Micheline Kamber, Jian Pei, "Data Mining Concepts and Techniques", Morgan Kaufman Publications, USA, 3rd Edition, 2012.
3. Judith Hurwitz, Alan Nugent, Dr. Fern Halper, and Marcia Kaufman, "Big Data for Dummies", John Wiley and Sons, Inc. New Jersey, 2013.
4. Ian H.Witten, Eibe Frank, "Data Mining – Practical Machine Learning Tools and Techniques", Morgan Kaufman Publications, San Francisco, 3rd Edition, 2011.
5. Seema Acharya, Subhashini Chellappan, "Big Data and analytics", Wiley Publications, India, 1st edition, 2015.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PSO1	PSO2
CO1	2	-	3	3	2
CO2	2	-	3	3	2
CO3	2	-	3	3	2
CO4	2	-	3	3	2
CO5	2	-	3	3	2
Avg.	**2**	**-**	**3**	**3**	**2**

1-low, 2-medium, 3-high

CS24T27	CLOUD COMPUTING	Category	L	T	P	C
		PCC	3	0	0	3

(Common to M.E CSE and M.E BDA)

PREREQUISITE

A basic understanding of cloud computing concepts and deployment models is needed. Familiarity with security principles and privacy concerns in IT is also required. Knowledge of major cloud platforms and their applications will be beneficial.

OBJECTIVES:

1. To Know the cloud computing concepts, deployment models, and architectural design.
2. To discover cloud deployment models and address security issues.
3. To examine privacy concerns and regulatory implications in cloud computing.
4. To learn about major industrial cloud platforms and their applications
5. To study cloud security measures, including infrastructure protection and privacy issues.

UNIT – I	CLOUD PLATFORM ARCHITECTURE	(9)

Cloud Computing: Definition, Characteristics – Cloud deployment models: public, private, hybrid, community – Categories of cloud computing – Everything as a service: Infrastructure, platform, software – A Generic Cloud Architecture Design – Layered cloud Architectural Development – Architectural Design Challenges.

UNIT – II	CLOUD DEPLOYMENT MODELS AND SECURITY ISSUES	(9)

Key Drivers to Adopting the Cloud – The Impact of Cloud Computing on Users – Governance in the Cloud – Barriers to Cloud Computing Adoption in the Enterprise. Infrastructure Security: Network Level – Host Level – Application Level – Data Security and Storage – Aspects of Data Security – Data Security Mitigation Provider Data and Security.

UNIT – III	PRIVACY ISSUES	(9)

Privacy Issues – Data Life Cycle – Key Privacy Concerns in the Cloud – Protecting Privacy – Changes to Privacy Risk Management and Compliance in Relation to Cloud Computing – Legal and Regulatory Implications – U.S. Laws and Regulations – International Laws and Regulations.

UNIT – IV	INDUSTRIAL PLATFORMS AND APPLICATIONS	(9)

Amazon web services – Google App Engine – Microsoft Azure – Scientific applications – Business and consumer applications.

UNIT – V	CLOUD SECURITY	(9)

Cloud Infrastructure security: network, host and application level – Aspects of data security, provider data and its security, Identity and access management architecture, IAM practices in the cloud, SaaS, PaaS, IaaS availability in the cloud – Key privacy issues in the cloud – Cloud Security and Trust Management

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, the students will be able to:

COs	Course Outcome	Cognitive Level
CO1	Recognize cloud architecture and design solutions	**Understand**
CO2	Examine cloud models and evaluate security issues.	**Understand**
CO3	Identify privacy concerns and apply regulations.	**Understand**
CO4	Compare cloud platforms and implement applications.	**Apply**
CO5	Make use of cloud security and implement protection measures.	**Apply**

REFERENCES:

1. Rajkumar Buyya, Christian Vacchiola, S.Thamarai Selvi, "Mastering Cloud Computing", MCGraw Hill Education, India, 1st Edition, 2013.
2. John W.Ritting house and James F.Ransome, "Cloud Computing: Implementation, Management, and Security", CRC Press, Florida, 2010.
3. Tim Mather, "Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance (Theory in Practice)", O'Reilly Media, California, 2nd Edition, 2009.
4. John Rhoton, "Cloud Computing Explained: Implementation Handbook for Enterprises", Saint Louis, New York, 1st, 2009.
5. Tom White, "Hadoop: The Definitive Guide", Yahoo Press, New York, 3rd Edition, 2012.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	-	2	3	2
CO2	3	-	2	3	2
CO3	3	-	2	3	2
CO4	3	-	2	3	2
CO5	3	-	2	3	2
Avg.	**3**	**-**	**2**	**3**	**2**

1-low, 2-medium, 3-high

BD24T27	MACHINE LEARNING TECHNIQUES	Category	L	T	P	C
		PCC	3	0	0	3

(Common to M.E CSE and M.E BDA)

PREREQUISITE

A fundamental understanding of mathematics, including probability and statistics, is essential. Basic programming skills, particularly in Python, are required. Familiarity with fundamental computer science concepts and data analysis techniques.

OBJECTIVES:

1. To provide a solid foundation in the core principles and mathematical foundations of machine learning.
2. To explore various supervised learning methods, including regression, classification, and neural networks.
3. To learn clustering and dimensionality reduction techniques in unsupervised learning.
4. To study the applications of graphical models like Bayesian Networks and Markov Random Fields.
5. To gain the concepts of reinforcement learning and sampling methods.

UNIT– I	BASICS OF MACHINE LEARNING	(9)

Machine Learning – Machine Learning Foundations – Overview – Design of a Learning System – Types of Machine learning – Applications Mathematical foundations of Machine Learning – Random Variables and Probabilities – Probability Theory – Probability Distributions – Decision Theory – Bayes Decision Theory – Information Theory.

UNIT – II	SUPERVISED LEARNING	(9)

Linear Models for Regression – Linear Models for Classification – Naive Bayes – Discriminant Functions – Probabilistic Generative Models – Probabilistic Discriminative Models – Bayesian Logistic Regression – Decision Trees – Classification Trees – Regression Trees – Pruning – Neural Networks – Feed Forward Network Functions – Back-Propagation – Support vector machines – Ensemble methods – Bagging – Boosting.

UNIT – III	UNSUPERVISED LEARNING	(9)

Clustering – K means – EM Algorithm – Mixtures of Gaussians – Curse of Dimensionality – Dimensionality Reduction – Factor Analysis – Principal Component Analysis – Probabilistic PCA.

UNIT – IV	PROBABILISTIC GRAPHICAL MODELS	(9)

Graphical Models – Undirected Graphical Models – Markov Random Fields – Directed Graphical Models – Bayesian Networks – Conditional Independence Properties – Inference – Generalization – Hidden Markov Models.

UNIT – V	ADVANCED LEARNING	(9)

Sampling – Basic Sampling methods – Monte Carlo. Reinforcement Learning – K-Armed Bandit – Elements – Model-Based Learning – Value Iteration – Policy Iteration –Temporal Difference Learning – Exploration Strategies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, the students will be able to:

COs	Course Outcome	Cognitive Level
CO1	Describe the fundamental concepts and mathematical foundations of machine learning.	**Understand**
CO2	Implement and apply various supervised learning models in real-world scenarios.	**Apply**
CO3	Recognize and apply unsupervised learning techniques like clustering and PCA.	**Understand**
CO4	Model and infer data using probabilistic graphical models.	**Understand**
CO5	Construct and implement advanced techniques like reinforcement learning.	**Apply**

REFERENCES:

1. Ethem Alpaydin, "Introduction to Machine Learning", MIT Press, London, 3rd Edition, 2014.
2. Kevin P. Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, London, 3rd Edition, 2012
3. Trevor Hastie, Robert Tibshirani and Jerome Friedman, "The Elements of Statistical Learning", Springer, United States, 2nd Edition, 2011.
4. Christopher Bishop, "Pattern Recognition and Machine Learning", Springer, United States, 1st Edition, 2007.
5. Tom M Mitchell, "Machine Learning", McGraw Hill Education, India, 1st Edition, 2013.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	1	3	2	1
CO2	3	1	3	2	1
CO3	3	1	3	2	1
CO4	3	1	3	2	1
CO5	3	1	3	2	1
Avg.	**3**	**1**	**3**	**2**	**1**

1-low, 2-medium, 3-high

BD24P26	BIG DATA MINING AND ANALYTICS LABORATORY	Category	L	T	P	C
		PCC	0	0	3	2

(Common to M.E CSE and M.E BDA)

PREREQUISITE

Students should have a basic understanding of big data concepts, programming skills (Java or Python), familiarity with data analysis tools (R) and knowledge of NoSQL databases (HBase, MongoDB). Additionally, they should be acquainted with distributed computing frameworks, particularly Apache Spark.

OBJECTIVES:

1. To install, configure, and run Hadoop and HDFS for big data processing.
2. To develop and implement MapReduce programs for data processing tasks such as word count and weather dataset analysis.
3. To apply SVM and clustering techniques using R for data analysis and visualization.
4. To implement applications that store and manage big data in HBase or MongoDB using Hadoop or R.
5. To install, deploy, and configure an Apache Spark cluster and execute applications using Spark.

List of Exercise/Experiments:

1. Install, configure and run Hadoop and HDFS.
2. Develop and execute MapReduce programs to count word frequencies.
3. Create a MapReduce program to process weather data.
4. Implement SVM and clustering techniques using R.
5. Visualize data using any plotting framework.
6. Build an application that stores big data in HBase or MongoDB using Hadoop or R.
7. Set up and configure an Apache Spark cluster, and run an application using Apache Spark

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, the students will be able to:

COs	Course Outcome	Cognitive Level
CO1	Demonstrate the ability to install, configure, and effectively manage Hadoop and HDFS for big data environments.	Apply
CO2	Develop and execute MapReduce programs for efficient data processing.	Apply

CO3	Apply SVM and clustering techniques in R and visualize data effectively.	Apply
CO4	Implement and manage storage solutions for large datasets using HBase or MongoDB, integrating them with Hadoop or R.	Apply
CO5	Deploy and use Apache Spark for distributed data processing applications.	Apply

REFERENCES:

1. Jure Leskovec, Anand Rajaraman, Jeffrey David Ullman, "Mining of Massive Datasets", Cambridge University Press, UK, 3rd Edition, 2020.
2. Seema Acharya, Subhashini Chellappan, "Big Data and analytics", Wiley Publications, India, 1st edition, 2015.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PSO1	PSO2
CO1	2	-	3	3	2
CO2	2	-	3	3	2
CO3	2	-	3	3	2
CO4	2	-	3	3	2
CO5	2	-	3	3	2
Avg.	**2**	**-**	**3**	**3**	**2**

1-low, 2-medium, 3-high

CS24P26	CLOUD COMPUTING LABORATORY	Category	L	T	P	C
		PCC	0	0	3	2

(Common to M.E CSE and M.E BDA)

PREREQUISITE

A basic understanding of virtualization, network protocols, and client-server architecture is required. Familiarity with network design tools and cloud computing concepts is also necessary.

OBJECTIVES:

1. To install and configure hypervisors; instantiate VMs.
2. To facilitate client-server communication between virtual machines by developing and executing a chat application.
3. To design and implement simple network topologies using network virtualization tools.
4. To provide students with hands-on experience in implementing network protocols using network controllers.
5. To develop students' ability to analyze and optimize scheduling mechanisms in cloud environments using simulation tools.

List of Exercise/Experiments:

1. a) Installation of various hypervisors and instantiation of VMs with image file using open source hypervisors such as Virtual Box, VMWare Player, Xen and KVM.
   b) Client server communication between two virtual machine instances, execution of chat application.
2. Creation of simple network topology using open source network virtualization tools (like mini net and others).
3. Implementation of simple network protocols using open source network controllers (like Open Daylight).
4. Implementation of various scheduling mechanisms using open source cloud simulator.
5. Familiarization and usage of the following cloud services with open source cloud tools (like Eucalyptus, Open stack, Open Nebula and others)
   a. Scheduling mechanisms
   b. Load balancing mechanisms
   c. Hashing and encryption mechanisms
6. Familiarization and usage of collaborative applications (SaaS).
7. Implementing applications using Google App Engine (PaaS).
   a. Develop MapReduce application (example-URL Pattern count and others) using Hadoop cluster set up (Single node and multi node).

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, the students will be able to:

COs	Course Outcome	Cognitive Level
CO1	Apply hypervisor installation and VM creation techniques.	Apply
CO2	Construct and manage VM client-server communication.	Apply
CO3	Design and implement basic network topologies.	Apply
CO4	Implement and manage network protocols with controllers.	Apply
CO5	Examine scheduling mechanisms in cloud environments to optimize resource allocation using simulation tools.	Apply

REFERENCES:

1. Rajkumar Buyya, Christian Vacchiola, S.Thamarai Selvi, "Mastering Cloud Computing" , MCGraw Hill Education, India, 1st Edition, 2013.
2. John W.Rittinghouse and James F.Ransome, "Cloud Computing: Implementation, Management, and Security", CRC Press, Florida, 2010.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	1	3	3	2
CO2	3	1	3	3	2
CO3	3	1	3	3	2
CO4	3	1	3	3	2
CO5	3	1	3	3	2
Avg.	**3**	**1**	**3**	**3**	**2**

1-low, 2-medium, 3-high

BD24P21	TECHNICAL PRESENTATION	Category	L	T	P	C
		EEC	0	0	3	2

PREREQUISITE

Students should start by conducting thorough research on their chosen topic, reviewing recent journals and conference papers. They must select their topic with guidance from faculty to ensure relevance. Additionally, students need to develop strong presentation skills to clearly and effectively communicate their findings, using appropriate visual aids.

OBJECTIVES:

1. To show expertise in the chosen topic with recent research.
2. To provide original insights based on critical analysis.
3. To communicate complex ideas clearly to the audience.
4. To align the topic with relevant program outcomes.
5. To encourage feedback and discussion to refine ideas.

Guidelines:

1. The students have to refer the journals, conference proceedings which are published recently.
2. By mutual discussions with the faculty, the student can choose a topic in specific area.
3. The student has to submit a technical report having 30 - 50 pages to the corresponding faculty one week before the final presentation.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, the students will be able to:

COs	Course Outcome	Cognitive Level
CO1	Deepen understanding of the topic and its relevance to recent research.	**Understand**
CO2	Present technical information clearly and confidently.	**Understand**
CO3	Conduct independent research and produce a coherent report.	**Understand**
CO4	Assess current research and identify future opportunities.	**Understand**
CO5	Receive feedback to refine research and presentation skills.	**Understand**

Mapping of COs with POs and PSOs					
COs/ POs	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**
CO1	**3**	**1**	**3**	**3**	**2**
CO2	**3**	**1**	**3**	**3**	**2**
CO3	**3**	**1**	**3**	**3**	**2**
CO4	**3**	**1**	**3**	**3**	**2**
CO5	**3**	**1**	**3**	**3**	**2**
Avg.	**3**	**1**	**3**	**3**	**2**
1-low, 2-medium, 3-high					

BD24E01	EMBEDDED SYSTEMS AND IIOT (PROFESSIONAL ELECTIVES – I and II)	Category	L	T	P	C
		PEC	3	0	0	3

PREREQUISITE
Students should have basic knowledge of electronics, C programming, and digital logic. Familiarity with microcontrollers and basic networking concepts is also recommended.

OBJECTIVES:
1. To learn the 8051-microcontroller architecture and programming.
2. To develop embedded systems using C programming.
3. To explore the architecture and components of IIOT.
4. To examine communication technologies in IIOT.
5. To study cloud and edge computing in IIOT.

UNIT – I	EMBEDDED PROCESSOR	(9)

Embedded processors – 8051 Microcontrollers – Architecture, Instruction set and programming. Programming parallel ports – Timers and serial port – Memory and I/O devices interfacing – Interrupt handling

UNIT – II	EMBEDDED C PROGRAMMING	(9)

Programming Embedded Systems in C – Memory And I/O Devices Interfacing – Implementing Timers, Interrupts and Serial communication in embedded C – Need for RTOS – Multiple Tasks and Processes – Context Switching – Priority Based Scheduling Policies.

UNIT – III	INTRODUCTION AND ARCHITECTURE OF IIOT	(9)

Introduction to IOT, IIOT, IOT Vs. IIOT – Architecture of IIoT – IOT node – Components of IIOT – Fundamentals of Control System – Components – Closed loop and Open loop system – IIOT System components: Sensors, Gateways, Routers, Modem, Cloud brokers, servers and its integration. Introduction to sensors – Types of sensors – working principle of basic Sensors – Ultrasonic Sensor – IR sensor – MQ2 – Temperature and Humidity Sensors – Roles of sensors and actuators in IIOT– Special requirements for IIOT sensors.

UNIT – IV	COMMUNICATION TECHNOLOGIES OF IIOT	(9)

HART– MODBUS Serial and Parallel – Ethernet – BACNet – Current – M2M. Need of protocols – Communication Protocols: Wi-Fi, Wi-Fi direct, IEEE 802.15.4, Zigbee, Z wave, BLE, SPI, RFID. Industry standards communication technology (COAP, LoRAWAN, OPC UA, MQTT AMQP IIOT).

UNIT – V	VISUALIZATION OF IIOT	(9)

Overview of Cots cloud platforms – predix, thingworx, azure. Frontend EDGE devices – Enterprise data for IIoT– Emerging descriptive data standards for IIoT – Cloud database – Cloud computing – Fog or Edge computing. Connecting an Arduino/Raspberry pi to the Web: Introduction – Setting up the Arduino/Raspberry pi development environment – Options for Internet connectivity with Arduino – Configuring Arduino/Raspberry pi board for the IoT.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, the students will be able to:

COs	Course Outcome	Cognitive Level
CO1	Identify the 8051microcontroller architecture	**Understand**
CO2	Design and implement embedded C programs	**Apply**
CO3	Differentiate between IoT and IIOT architectures.	**Understand**
CO4	Infer communication protocols for IIOT.	**Understand**
CO5	Implement cloud and edge computing in IIOT.	**Apply**

REFERENCES:

1. Muhammed Ali Mazidi, Janice Gillispie Mazidi, Rolin D. McKinlay, "The 8051 Microcontroller and Embedded Systems", Pearson Education, India, 2nd Edition, 2014.
2. Michael J. Pont, "Embedded C", Pearson Education, India, 1st Edition, 2007
3. Robert Barton, Patrick Grossetete, David Hanes, Jerome Henry, Gonzalo Salgueiro, "loT Fundamentals: Networking Technologies, Protocols and Use Cases for the Internet of Things", CISCO Press, USA, 1st Edition, 2017.
4. Olivier Hersent, David Boswarthick, Omar Elloumi, "The Internet of Things: Key Applications and Protocols", Willy Publications, India, 1st Edition, 2012.
5. Wayne Wolf, "Computers as Components: Principles of Embedded Computer System Design", Elsevier, USA, 4th Edition, 2017.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PSO1	PSO2
CO1	2	1	3	2	3
CO2	2	1	3	2	3
CO3	2	1	3	2	3
CO4	2	1	3	2	3
CO5	2	1	3	2	3
Avg.	**2**	**1**	**3**	**2**	**3**

1-low, 2-medium, 3-high

BD24E02	STATISTICS FOR BUSINESS ANALYTICS (PROFESSIONAL ELECTIVES – I and II)	Category	L	T	P	C
		PEC	3	0	0	3

PREREQUISITE

Students should have a foundational understanding of basic statistics, including probability theory and descriptive statistics. Familiarity with fundamental concepts of regression analysis and hypothesis testing is also recommended. Additionally, knowledge of mathematical concepts related to linear algebra and calculus.

OBJECTIVES:

1. To explore the fundamentals of time series analysis, including its components, models, and methods for trend determination.
2. To master methods of estimation, including random sampling, unbiased estimators, consistency, and maximum likelihood estimation.
3. To study principles of statistical inference and decision theory, focusing on variance bounds, unbiased estimators, and optimal decision rules.
4. To explore various regression methods and evaluate system reliability, including reliability bounds and assessment techniques.
5. To learn and apply concepts of statistical quality control, including process control, control charts, and interpretation of patterns.

UNIT – I	INTRODUCTION TO TIME SERIES	(9)

Time Series: Meaning and Need of Time Series Analysis – Components of Time Series – Additive and multiplicative Model – Utility of Time Series – Methods of Determining Trends – Smoothing Auto Correlation – Stationarity – Concepts Of AR, MA, ARMA.

UNIT – II	ESTIMATION	(9)

Methods of estimation: Random samples – Sampling distributions of estimators – Methods of moments – Unbiasedness: Unbiased estimator – Illustration of unbiased estimator for the parameter and parametric function – Definitions of Consistency – Sufficient condition for consistency – Concept of efficiency and sufficiency – Neyman-Factorization theorem (without proof) – Concept of likelihood function – Maximum Likelihood – Properties of MLE (without proof).

UNIT – III	STATISTICAL INFERENCE AND DECISION THEORY	(9)

Statement and proof of Cramer Rao inequality – Definition of Minimum Variance Bound Unbiased Estimator (MVBUE) of $\varphi(\theta)$ (statement only – Rao-Blackwell theorem – Lehmann-Scheffe theorem – Procedure to obtain MVUE (statement only) – Minimum Variance Unbiased Estimator (MVUE) and Uniformly Minimum Variance Unbiased Estimator(UMVUE) – Basic elements of Statistical Decision Problem – Expected loss – Decision rules(nonrandomized and randomized) – Decision principles (conditional Bayes, frequentist) – Inference as a decision problem – Optimal decision rules.

UNIT – IV	REGRESSION AND RELIABILITY	(9)

Multiple linear regression – Forward, Backward and Stepwise regression – Logistic Regression – Reliability of system of independent components – Association of random variables – Bounds on system reliability – Improved bounds on system reliability using modular decompositions – Replacement policy comparisons – Preservation of life distribution classes under reliability operations – Reversed hazard rate – Cumulative reversed hazard function – Relation between hazard function and reversed hazard function.

UNIT – V	STATISTICAL QUALITY CONTROL	(9)

Meaning and purpose of Statistical quality control – Concept of process control – Product control – assignable causes – Chance causes and rational subgroups – Control charts and their uses – Choice of subgroup sizes – Construction of control chart for (mean), R (range), s (standard deviation), c (no.of defectives), p (fraction defectives) with unequal subgroup size – Interpretation of non-random patterns of points – Modified control chart – CUSUM Chart.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, the students will be able to:

COs	Course Outcome	Cognitive Level
CO1	Describe the components and models of time series analysis, including additive and multiplicative models.	**Understand**
CO2	Utilize methods of moments, maximum likelihood, and other estimation techniques to derive unbiased and consistent estimators.	**Apply**
CO3	Assess and compare statistical inference techniques, including variance bounds and decision rules, to determine optimal decision-making strategies.	**Analyze**
CO4	Examine and review the effectiveness of regression models and reliability bounds in evaluating system performance.	**Apply**
CO5	Develop and interpret various statistical quality control charts, such as control charts and CUSUM charts, to monitor and improve process quality.	**Apply**

REFERENCES:

1. Johnson, R.A., Miller, I and Freund J., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, 2015.
2. Douglas C. Montgomery, Elizabeth A. Peck, G. Geoffrey Vining, "Introduction to Linear Regression Analysis", Wiley, 6th Edition, 2021.
3. Devore. J.L., "Probability and Statistics for Engineering and the Sciences‖, Cengage Learning, New Delhi, 8th Edition, 2014.
4. P. J. Bickel and K. A. Docksum, "Statistical Inference", Prentice Hall, 2 nd Edition, 2015.
5. Chris Chatfield "The Analysis of Time Series: An Introduction", Chapman & Hall/CRC, 6th Edition, 2003.
6. George Casella, Roger L. Berger, "Statistical Inference", Thomson Learning, 2 nd Edition, 2007.
7. Rao, C.R, "Linear Statistical Inference and its Applications", Wiley Eastern, 2009.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PSO1	PSO2
CO1	2	1	3	3	2
CO2	2	1	3	3	2
CO3	2	1	3	3	2
CO4	2	1	3	3	2
CO5	2	1	3	3	2
Avg.	**2**	**1**	**3**	**3**	**2**

1-low, 2-medium, 3-high

CS24E04	OBJECT ORIENTED SOFTWARE ENGINEERING (PROFESSIONAL ELECTIVES – I and II)	Category	L	T	P	C
		PEC	3	0	0	3

(Common to M.E CSE and M.E BDA)

PREREQUISITE

Students should have basic programming skills in an object-oriented language like Java or C++ and a solid understanding of software engineering principles. Familiarity with core data structures and algorithms is essential, along with experience using UML for modeling designs.

OBJECTIVES:

1. To introduce core software engineering concepts and Agile methodologies.
2. To teach skill for gathering, analyzing, and specifying software requirements.
3. To cover software design principles, patterns, and architectural styles.
4. To provide knowledge of testing methods and debugging techniques.
5. To learn skills in software project management and DevOps practices.

UNIT – I	SOFTWARE PROCESS AND AGILE DEVELOPMENT	(9)

Introduction to Software Engineering – Software Process – Perspective and Specialized Process Models – Introduction to Agility – Agile process – Extreme programming – XP Process.

UNIT – II	REQUIREMENTS ANALYSIS AND SPECIFICATION	(9)

Requirement analysis and specification – Requirements gathering and analysis – Software Requirement Specification – Formal system specification – Finite State Machines – Petrinets – Object modelling using UML – Use case Model – Class diagrams – Interaction diagrams – Activity diagrams – State chart diagrams – Functional modelling – Data Flow Diagram – Case Tools.

UNIT – III	SOFTWARE DESIGN	(9)

Software design – Design process – Design concepts – Coupling – Cohesion – Functional independence – Design patterns – Model-view-controller – Publish-subscribe – Adapter – Command – Strategy – Observer – Proxy – Facade – Architectural styles – Layered – Client Server – Tiered Pipe and filter – User interface design.

UNIT – IV	SOFTWARE TESTING AND MAINTENANCE	(9)

Testing – Unit testing – Black box testing – White box testing – Integration and System testing – Regression testing – Debugging – Program analysis – Symbolic execution – Model Checking.

UNIT – V	PROJECT MANAGEMENT	(9)

Software Project Management – Software Configuration Management – Project Scheduling – DevOps: Motivation – Cloud as a platform – Operations – Deployment Pipeline: Overall Architecture Building and Testing – Deployment – Tools – Case Study.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, the students will be able to:

COs	Course Outcome	Cognitive Level
CO1	Apply fundamental software engineering concepts and Agile methodologies to projects.	**Apply**
CO2	Develop and analyze software requirements.	**Analyze**
CO3	Design software systems using appropriate design patterns and architectural styles.	**Apply**
CO4	Perform various testing and maintenance activities to ensure software quality.	**Understand**
CO5	Manage software projects, including scheduling, configuration, and applying DevOps practices.	**Apply**

REFERENCES:

1. Bernd Bruegge and Allen H. Dutoit, "Object-Oriented Software Engineering: Using UML, Patterns and Java", Pearson Education, India, 3rd Edition, 2013.
2. Roger S. Pressman, "Object-Oriented Software Engineering: An Agile Unified Methodology", Mc Graw-Hill, 1st Edition, 2014
3. Carlo Ghezzi, Mehdi Jazayeri, Dino Mandrioli, "Fundamentals of Software Engineering", PHI Learning Pvt. Ltd, 2nd Edition, 2010.
4. Len Bass, Ingo Weber and Liming Zhu, "DevOps: A Software Architect's Perspective", Pearson Education, 2016.
5. Stephen Schach, "Object-Oriented and Classical Software Engineering", McGraw-Hill, 8th Edition, 2010

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	1	3	2	3
CO2	3	1	3	2	3
CO3	3	1	3	2	3
CO4	3	1	3	2	3
CO5	3	1	3	2	3
Avg.	**3**	**1**	**3**	**2**	**3**

1-low, 2-medium, 3-high

BD24E03	DATA VISUALIZATION TECHNIQUES (PROFESSIONAL ELECTIVES – I and II)	Category	L	T	P	C
		PEC	3	0	0	3

PREREQUISITE

Students should have a basic understanding of data analysis and statistics. Familiarity with programming languages like Python or R and knowledge of database concepts are essential. Additionally, a grasp of graphic design principles and experience with web technologies will be beneficial.

OBJECTIVES:

1. To learn the basics of data visualization and design principles.
2. To explore the techniques for visualizing time-series, trees, and graphs.
3. To study methods for text and document visualization.
4. To make interactive visualizations using tools like D3.js and Tableau.
5. To gain the skills of security measures in data visualization systems.

UNIT – I	BASICS OF VISUALIZATION	(9)

Context of data visualization – Definition, Methodology, Visualization design objectives. Key Factors – Purpose, Visualization function and Tone, Visualization design options – Data representation, Data Presentation, Seven stages of Data visualization, Widgets, Data visualization tools. Mapping – Time Series – Connections and Correlations – Scatterplot Maps –Trees, Hierarchies and Recursion – Networks and Graphs.

UNIT – II	VISUALIZATION TECHNIQUES FOR TIME-SERIES, TREES AND GRAPHS	(9)

Mapping – Time series – Connections and correlations – Indicator Area chart – Pivot table – Scatter charts – Scatter maps – Tree maps – Space filling and non-space filling methods – Hierarchies and Recursion – Networks and Graphs – Displaying Arbitrary Graphs – Node link graph – Matrix representation for graphs.

UNIT – III	TEXT AND DOCUMENT VISUALIZATION	(9)

Acquiring data –Tools for Acquiring Data from the Internet – Locating Files for Use with Processing – Loading Text Data – Dealing with Files and Folders – Listing Files in a Folder – Asynchronous Image Downloads – Web Techniques – Parsing data – Levels of Effort – Tools for Gathering Clues – Text Markup Languages – Regular Expressions – Grammars and BNF Notation – Compressed Data – Vectors and Geometry – Binary Data Formats – Advanced Detective Work.

UNIT – IV	INTERACTIVE DATA VISUALIZATION	(9)

Drawing with data – Scales – Axes – Updates –Transition and Motion – Interactivity - Layouts – Geo mapping – Exporting – Framework – D3.js –Tableau Dashboards.

UNIT – V	SECURITY IN DATA VISUALIZATION	(9)

Port scan visualization – Vulnerability assessment and exploitation – Firewall log visualization – Intrusion detection log visualization – Attacking and defending visualization systems – Creating secured visualization system.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, the students will be able to:

COs	Course Outcome	Cognitive Level
CO1	Comprehend the Key data visualization concepts.	**Understand**
CO2	Utilize the Advanced techniques for visualizing data.	**Apply**
CO3	Develop the Visualizations for text and documents.	**Apply**
CO4	Construct for Interactive visualizations using appropriate tools.	**Apply**
CO5	Assess the Security measures in data visualization systems.	**Apply**

REFERENCES:

1. Robert Spence, "Information Visualization an Introduction", Pearson Education, USA, 3rd Edition, 2014.
2. Colin Ware, "Information Visualization Perception for Design", Margon Kaufmann Publishers, USA, 4th Edition, 2021.
3. Joerg Osarek, "Virtual Reality Analytics", Gordon's Arcade Publication, Germany, 2nd Edition, 2016.
4. Alexandru C. Telea, "Data Visualization: Principles and Practice", CRC Press, USA,2nd Edition, 2015.
5. Matthew Ward, Georges Grinstein and Daniel Keim, "Interactive Data Visualization Foundations, Techniques, Applications", CRC Press, USA, 2nd Edition, 2015.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	2	3	2	1
CO2	3	2	3	2	1
CO3	3	2	3	2	1
CO4	3	2	3	2	1
CO5	3	2	3	2	1
Avg.	**3**	**2**	**3**	**2**	**1**

BD24E04	AGILE METHODOLOGIES (PROFESSIONAL ELECTIVES – I and II)	Category	L	T	P	C
		PEC	3	0	0	3

(Common to M.E CSE and M.E BDA)

PREREQUISITE

Success in this course requires a basic understanding of software development and software engineering concepts, including requirements and testing. Familiarity with traditional project management is helpful for contrasting with Agile. Experience in team collaboration and an interest in iterative development are also important.

OBJECTIVES:

1. To provide the core theories and principles of Agile methodologies.
2. To learn about various Agile processes like SCRUM and Extreme Programming.
3. To develop skills to manage and share knowledge effectively within Agile teams.
4. To gain expertise in handling requirements engineering in an Agile context.
5. To learn Agile approaches to quality assurance, including Test Driven Development.

UNIT – I	BASICS OF AGILE METHODOLOGY	(9)

Theories for Agile Management – Agile Software Development – Traditional Model vs. Agile Model – Classification of Agile Methods – Agile Manifesto and Principles – Agile Project Management – Agile Team Interactions – Ethics in Agile Teams – Agility in Design, Testing – Agile Documentations – Agile Drivers, Capabilities and Values.

UNIT – II	AGILE PROCESSES	(9)

Lean Production – SCRUM, Crystal, Feature Driven Development – Adaptive Software Development – Extreme Programming: Method Overview – Lifecycle – Work Products, Roles and Practices.

UNIT– III	AGILITY AND KNOWLEDGE MANAGEMENT	(9)

Agile Information Systems – Agile Decision Making – Earl's Schools of KM – Institutional Knowledge Evolution Cycle – Development, Acquisition, Refinement, Distribution, Deployment, leveraging – KM in Software Engineering – Managing Software Knowledge – Challenges of Migrating to Agile Methodologies – Agile Knowledge Sharing – Role of Story-Cards – Story-Card Maturity Model (SMM).

UNIT – IV	AGILITY AND REQUIREMENTS ENGINEERING	(9)

Impact of Agile Processes in RE – Current Agile Practices – Variance – Overview of RE Using Agile – Managing Unstable Requirements – Requirements Elicitation – Agile Requirements Abstraction Model – Requirements Management in Agile Environment – Agile Requirements Prioritization – Agile Requirements Modeling and Generation – Concurrency in Agile Requirements Generation.

UNIT – V	AGILITY AND QUALITY ASSURANCE	(9)

Agile Product Development – Agile Metrics – Feature Driven Development (FDD) – Financial and Production Metrics in FDD – Agile Approach to Quality Assurance – Test Driven Development – Agile Approach in Global Software Development.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, the students will be able to:

COs	Course Outcome	Cognitive Level
CO1	Apply Agile methodologies in real-world projects.	**Apply**
CO2	Use Agile tools like SCRUM and FDD effectively.	**Understand**
CO3	Effectively manage and distribute knowledge in Agile environments.	**Understand**
CO4	Handle Agile requirements engineering with proficiency.	**Understand**
CO5	Implement Agile quality assurance to ensure high-quality software.	**Apply**

REFERENCES:

1. Dingsoyr, Torgeir, Dyba, Tore, Moe, Nils Brede (Eds.), "Agile Software Development, Current Research and Future Directions", Springer-Verlag Berlin Heidelberg, UK, 1st Edition, 2010.
2. David J. Anderson; Eli Schragenheim, "Agile Management for Software Engineering: Applying the Theory of Constraints for Business Results", Prentice Hall, India, 1st Edition, 2003
3. Hazza & Dubinsky, "Agile Software Engineering, Series: Undergraduate Topics in Computer Science", Springer, UK, 8th Edition, 2009
4. Craig Larman, "Agile and Iterative Development: A managers Guide", Addison-Wesley, New York, 2nd Edition, 2004
5. Kevin C. Desouza, "Agile information systems: conceptualization, construction, and management, Butterworth-Heinemann", Penguin Books Ltd, UK, 1st Edition, 2007.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	1	2	2	3
CO2	3	1	2	2	3
CO3	3	1	2	2	3
CO4	3	1	2	2	3
CO5	3	1	2	2	3
Avg.	**3**	**1**	**2**	**2**	**3**

1-low, 2-medium, 3-high

CS24E06	MULTI CORE ARCHITECTURES (PROFESSIONAL ELECTIVES – I and II)	Category	L	T	P	C
		PEC	3	0	0	3

(Common to M.E CSE and M.E BDA)

PREREQUISITE

Students should have a basic understanding of computer architecture and digital logic design. Familiarity with programming concepts and performance measurement techniques is also required. Prior knowledge of parallel computing and memory systems is beneficial.

OBJECTIVES:

1. To learn the basics of computer design, performance measurement, and ILP.
2. To study cache performance, virtual memory, and memory hierarchy design.
3. To examine shared memory architectures, cache coherence, and synchronization.
4. To explore homogeneous and heterogeneous multicore designs and their applications.
5. To assess vector architectures, SIMD extensions, and GPU computing.

UNIT – I	FUNDAMENTALS OF COMPUTER DESIGN AND ILP	(9)

Fundamentals of Computer Design – Measuring and Reporting Performance – Instruction Level Parallelism and its Exploitation – Concepts and Challenges – Limitations of ILP – Multithreading – SMT and CMP Architectures – The Multicore era.

UNIT – II	MEMORY HIERARCHY DESIGN	(9)

Introduction – Optimizations of Cache Performance – Memory Technology and Optimizations – Protection: Virtual Memory and Virtual Machines – Design of Memory Hierarchies – Case Studies.

UNIT – III	MULTIPROCESSOR ISSUES	(9)

Symmetric and Distributed Shared Memory Architectures – Cache Coherence Issues – Performance Issues – Synchronization Issues – Models of Memory Consistency – Interconnection Networks – Buses, Crossbar and Multi-Stage Interconnection Networks.

UNIT – IV	MULTICORE ARCHITECTURES	(9)

Homogeneous and Heterogeneous Multicore Architectures – Intel Multicore Architectures – SUN CMP Architecture – IBM Cell Architecture – Introduction to Warehouse – Scale Computers, Cloud Computing – Architectures and Issues – Case Studies.

UNIT – V	VECTOR AND GPU ARCHITECTURES	(9)

Vector Architecture – SIMD Extensions for Multimedia – Graphics Processing Units – Case Studies – GPGPU Computing – Detecting and Enhancing Loop Level Parallelism.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, the students will be able to:

COs	Course Outcome	Cognitive Level
CO1	Describe fundamental concepts of computer design, performance metrics, and instruction-level parallelism	**Understand**
CO2	Apply principles to optimize cache performance and design efficient memory hierarchies	**Apply**
CO3	Analyze issues related to cache coherence, synchronization, and memory consistency in multiprocessor systems	**Analyze**
CO4	Compare different multicore architectures and their effectiveness in various computing environments	**Understand**
CO5	Use knowledge of vector and GPU architectures to improve performance in parallel computing tasks	**Understand**

REFERENCES:

1. John L. Hennessey and David A. Patterson, "Computer Architecture – A Quantitative Approach", Morgan Kaufmann, Elsevier, Netherlands, 5th Edition, 2012.
2. Darryl Gove, "Multicore Application Programming: For Windows, Linux, and Oracle Solaris", Pearson, New Delhi, 2nd Edition, 2011.
3. David B. Kirk, Wen-mei W. Hwu, "Programming Massively Parallel Processors", Elsevier Inc, 1st Edition, 2010.
4. Wen–mei W. Hwu, "GPU Computing Gems", Morgan Kaufmann / Elsevier, 2nd Edition, 2011.
5. KaiHwang, "Advanced Computer Architecture", Tata McGraw-Hill Education, 3rd Edition, 2003.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PSO1	PSO2
CO1	2	1	3	3	2
CO2	2	1	3	3	2
CO3	2	1	3	3	2
CO4	2	1	3	3	2
CO5	2	1	3	3	2
Avg.	**2**	**1**	**3**	**3**	**2**

1-low, 2-medium, 3-high

BD24E05	WEB SERVICES AND API DESIGN (PROFESSIONAL ELECTIVES – I and II)	Category	L	T	P	C
		PEC	3	0	0	3

(Common to M.E CSE and M.E BDA)

PREREQUISITE

Students should know web development basics, HTTP protocols, and XML/JSON formats. Familiarity with programming and object-oriented design is recommended and general software engineering principles.

OBJECTIVES:

1. To learn the architecture and design principles of web services and Service-Oriented Architecture
2. To study the building blocks of web services, including SOAP, WSDL, and UDDI.
3. To discover the fundamentals of RESTful web services, including HTTP methods and client interactions.
4. To gain hands-on experience with implementing RESTful web services using technologies like Spring and S3.
5. To learn to design and implement resource-oriented services, focusing on URIs, statelessness, and resource representation.

UNIT – I	BASICS OF WEB SERVICE	(9)

Overview – Web Service Architecture – Service-Oriented Architecture (SOA) – Architecting Web Services: Web Services Technology Stack – Logical Architectural View – Deployment Architectural View and Process Architectural View.

UNIT – II	WEB SERVICE BUILDING BLOCKS	(9)

Introduction to SOAP: SOAP Syntax – Sending SOAP Messages – SOAP Implementations – Introduction to WSDL: WSDL Syntax – SOAP Binding – WSDL Implementations – Introduction to UDDI: The UDDI API – Implementations –The Future of UDDI.

UNIT – III	RESTFUL WEB SERVICES	(9)

Programmable Web – HTTP: Documents in Envelopes – Method Information – Scoping Information – The Competing Architectures – Technologies on the Programmable Web – Leftover Terminology – Writing Web Service Clients: The Sample Application – Making the Request: HTTP Libraries – Processing the Response: XML Parsers.

UNIT – IV	IMPLEMENTATION OF RESTFUL WEB SERVICES	(9)

Introducing the Simple Storage Service – Object-Oriented Design of S3 – Resources – HTTP Response Codes Resource – URIs – Addressability – Statelessness – Representations – Links and Connectedness – The Uniform Interface – Spring Web Services – Spring MVC Components – Spring Web Flow – A Service Implementation using Spring Data REST.

UNIT – V	RESOURCE ORIENTED ARCHITECTURE	(9)

Resource – URIs – Addressability – Statelessness – Representations – Links and Connectedness – The Uniform Interface – Designing Read-Only Resource-Oriented Services: Resource Design – Turning Requirements into Read-Only Resources – Figure Out the Data Set – Split the Data Set into Resources – Name the Resources – Design Representation – Link the Resources to Each Other – The HTTP Response.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, the students will be able to:

COs	Course Outcome	Cognitive Level
CO1	Describe web service architecture and SOA principles.	**Understand**
CO2	Identify and explain SOAP, WSDL, and UDDI components.	**Understand**
CO3	Apply RESTful principles to create and manage web services.	**Apply**
CO4	Implement RESTful services using frameworks like Spring and S3.	**Apply**
CO5	Develop and structure web services based on resource-oriented architecture principles.	**Apply**

REFERENCES:

1. Leonard Richardson and Sam Ruby, "RESTful Web Services", O'Reilly Media, 1st Edition, 2007
2. McGovern, et al., "Java Web Services Architecture", Morgan Kaufmann Publishers, 2nd Edition, 2005.
3. Lindsay Bassett, "Introduction to JavaScript Object Notation", O'Reilly Media, 2nd Edition, 2015
4. Craig Walls, "Spring in Action", Manning Publications, Shelter Island, 5th Edition, 2018
5. Raja CSP Raman, Ludovic Dewailly, "Building A RESTful Web Service with Spring 5", Packt Publishing, 2nd Edition,2018.
6. Bogunuva Mohanram Balachandar, "Restful Java Web Services: A pragmatic guide to designing and building RESTful APIs using Java", Ingram short title, 3rd Edition, 2017.
7. Mario-Leander Reimer, "Building RESTful Web Services with Java EE 8: Create modern RESTful web services with the Java EE 8 API", Packt publishing, 2nd Edition, 2018.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	1	2	3	1
CO2	3	1	2	3	1
CO3	3	1	2	3	1
CO4	3	1	2	3	1
CO5	3	1	2	3	1
Avg.	**3**	**1**	**2**	**3**	**1**

1-low, 2-medium, 3-high

BD24E06	HIGH PERFORMANCE COMPUTING FOR BIG DATA (PROFESSIONAL ELECTIVES – I and II)	Category	L	T	P	C
		PEC	3	0	0	3

PREREQUISITE
Students should have basic skills in data analysis, programming language and database management. Familiarity with networking concepts and introductory knowledge of big data technologies.

OBJECTIVES:
1. To provide students with a solid understanding of HPC paradigms and their impact on big data analytics.
2. To design and implement effective network and software solutions for big data analytics.
3. To teach real-time analytics technologies for effective data processing.
4. To address security and privacy issues in big data systems and implement effective measures.
5. To use emerging technologies and accelerators for innovative solutions in big data applications.

UNIT – I	BASICS OF HIGH PERFORMANCE COMPUTING	(9)

The Emerging IT Trends – Apache Hadoop for big data analytics – Big data into big insights and actions – Emergence of BDA discipline – Strategic implications of big data – BDA Challenges – HPC paradigms – Cluster computing – Grid Computing – Cloud computing – Heterogeneous computing – Mainframes for HPC – Supercomputing for BDA – Appliances for BDA.

UNIT – II	NETWORK AND SOFTWARE INFRASTRUCTURE FOR HIGH PERFORMANCE BDA	(9)

Design of Network Infrastructure for high performance BDA – Network Virtualization – Software Defined Networking – Network Functions Virtualization – WAN optimization for transfer of big data – Started with SANs – Storage infrastructure requirements for storing big data – FC SAN – IP SAN – NAS – GFS.

UNIT – III	REAL TIME ANALYTICS USING HIGH PERFORMANCE COMPUTING	(9)

Technologies that support Real time analytics – MOA: Massive online analysis – GPFS: General parallel file system – Client case studies – Key distinctions – Machine data analytics – Operational analytics – HPC Architecture models – In Database analytics – In memory analytics.

UNIT – IV	SECURITY AND TECHNOLOGIES	(9)

Security, Privacy and Trust for user – Generated content: The challenges and solutions – Role of real time big data processing in the IoT – End to End Security Framework for big sensing data streams – Clustering in big data.

UNIT – V	EMERGING BIG DATA APPLICATIONS	(9)

Deep learning Accelerators – Accelerators for clustering applications in machine learning – Accelerators for classification algorithms in machine learning – Accelerators for Big data Genome Sequencing.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, the students will be able to:

COs	Course Outcome	Cognitive Level
CO1	Describe high-performance computing models and their role in big data.	**Understand**
CO2	Design and deploy network and storage systems for big data.	**Apply**
CO3	Compare technologies like MOA and GPFS for real-time data processing.	**Apply**
CO4	Examine and address security and privacy issues in big data systems.	**Apply**
CO5	Apply techniques like deep learning accelerators for big data applications.	**Apply**

REFERENCES:

1. Pethuru Raj, Anupama Raman, Dhivya Nagaraj and Siddhartha Duggirala, "High Performance Big-Data Analytics: Computing Systems and Approaches", Springer, USA, 1st Edition, 2015.
2. Kuan-Ching Li, Hai Jiang, Albert Y. Zomaya, "Big Data Management and Processing", CRC Press, USA, 1st Edition, 2017.
3. Chao wang, "High Performance Computing for Big Data: Methodologies and Applications", CRC Press, USA, 1st Edition, 2018.
4. Khosrow Hassibi, "High-Performance Data Mining and Big Data Analytics", Create Space Independent Publishing Platform, US, 1st Edition,2014.
5. Thomas Sterling, Matthew Anderson, "High performance computing: Modern systems and practices", Morgan Kaufmann publishers, US, 1st Edition, 2017.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PSO1	PSO2
CO1	2	-	3	3	1
CO2	2	-	3	3	1
CO3	2	-	3	3	1
CO4	2	-	3	3	1
CO5	2	-	3	3	1
Avg.	**2**	**-**	**3**	**3**	**1**

1-low, 2-medium, 3-high

CS24T18	NETWORK TECHNOLOGIES (PROFESSIONAL ELECTIVES – I and II)	Category	L	T	P	C
		PCC	3	0	0	3

(Common to M.E CSE and M.E BDA)

PREREQUISITE

Students should have a basic understanding of networking terminology, OSI model principles and network devices. Familiarity with IP addressing, wireless networks, and virtualization concepts is also needed. Basic knowledge of programming and network security.

OBJECTIVES:

1. To introduce fundamental networking concepts, devices and terminology.
2. To explore different wireless network technologies and standards.
3. To review sophisticated mobile network technologies and protocols
4. To learn the principles and architecture of Software Defined Networking (SDN).
5. To study the design and advantages of Network Functions Virtualization (NFV)

UNIT – I	NETWORKING CONCEPTS	(9)

Peer To Peer Vs Client-Server Networks – Network Devices – Network Terminology – Network Speeds – Network throughput delay – OSI Model Packets – Frames – Headers – Collision and Broadcast Domains – LAN Vs WAN Network Adapter – Hub – Switch – Router – Firewall – IP addressing.

– UNIT – II	WIRELESS NETWORKS	(9)

Wireless access techniques – IEEE 802.11a, 802.11g, 802.11e, 802.11n/ac/ax/ay/ba/be, QoS – Bluetooth – Protocol Stack – Security – Profiles – zigbee

UNIT – III	MOBILE DATA NETWORKS	(9)

4G Networks and Composite Radio Environment – Protocol Boosters – Hybrid 4G Wireless Networks Protocols – Green Wireless Networks – Physical Layer and Multiple Access – Channel Modelling for 4G – Concepts of 5G – Channel access – Air Interface – Cognitive Radio – Spectrum Management – C-RAN Architecture – Vehicular Communications – Protocol – Network Slicing – MIMO – mmWave – Introduction to 6G.

UNIT – IV	SOFTWARE DEFINED NETWORKS	(9)

SDN Architecture – Characteristics of Software – Defined Networking – SDN and NFV Related Standards – SDN Data Plane – Data Plane Functions – Data Plane Protocols – OpenFlow Logical Network Device – Flow Table Structure – Flow Table Pipeline – Use of Multiple Tables – Group Table – OpenFlow Protocol – SDN Control Plane Architecture – Control Plane Functions – Southbound Interface – Northbound Interface – Routing – ITU-T Model.

UNIT – V	NETWORK FUNCTIONS VIRTUALIZATION	(9)

Motivation – Virtual Machines – NFV Benefits and Requirements – Architecture – NFV Infrastructure – Virtualized Network Functions – NFV Management and Orchestration – NFV Use Cases – NFV and SDN – Network virtualization – VLAN and VPN.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, the students will be able to:

COs	Course Outcome	Cognitive Level
CO1	Identify and apply fundamental networking concepts and terminology.	**Apply**
CO2	Familiarize with and assess various wireless network technologies and standards.	**Understand**
CO3	Examine and critique advanced mobile network technologies and protocols.	**Apply**
CO4	Comprehend and implement the principles and architecture of Software Defined Networking (SDN).	**Apply**
CO5	Realize and appraise the design and advantages of Network Functions Virtualization (NFV).	**Understand**

REFERENCES:

1. James Bernstein, "Networking made Easy", Independently Published, 1st Edition, 2018.
2. Houda Labiod, Costantino de Santis, Hossam Afifi, "Wi-Fi, Bluetooth, Zigbee and WiMax", Springer, Netherlands, 1st Edition, 2007.
3. Erik Dahlman, Stefan Parkvall, Johan Skold, "4G: LTE/LTE-Advanced for Mobile Broadband", Academic Press, Cambridge, 1st Edition, 2013.
4. Saad Z. Asif, "5G Mobile Communications Concepts and Technologies", CRC press, Florida, 1st Edition, 2019.
5. William Stallings, "Foundations of Modern Networking: SDN, NFV, QoE, IoT, and Cloud", Pearson Education, 1st Edition, 2016.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	1	1	3	1
CO2	3	1	1	3	1
CO3	3	1	1	3	1
CO4	3	1	1	3	1
CO5	3	1	1	3	1
Avg.	**3**	**1**	**1**	**3**	**1**

1-low, 2-medium, 3-high

BD24E07	DATA INTENSIVE COMPUTING (PROFESSIONAL ELECTIVES – I and II)	Category	L	T	P	C
		PEC	3	0	0	3

PREREQUISITE

Students should have a foundational understanding of distributed systems and databases, including knowledge of file systems and data parallelism. Proficiency in programming and familiarity with basic concepts of cloud computing and NoSQL databases is essential.

OBJECTIVES:

1. To provide a comprehensive overview of distributed systems, including data parallelism, Hadoop, and NoSQL databases.
2. To architect high-performance network and software systems for data-intensive computing.
3. To teach effective load balancing, resource management, and processing techniques for large-scale data analytics.
4. To address and implement security and privacy measures for data-intensive computing systems.
5. To explore applications of data-intensive computing in various domains and future trends in cloud and grid computing.

UNIT – I	BASICS OF DATA INTENSIVE	(9)

Introduction to Distributed systems – Databases Vs. File Systems – Distributed file systems – Distributed Machine Learning System – Data Parallelism – Characteristics – Hadoop – Execution Engines – Map Reduce – Distributed Storage System for Structured Data – NoSQL databases – Casandra – Mongo DB Developing a Distributed Application.

UNIT – II	ARCHITECTURES AND SYSTEMS	(9)

High performance Network Architectures for Data intensive Computing – Architecting Data Intensive Software systems – ECL/HPCC: A Unified approach to Big Data – Scalable storage for Data Intensive Computing – Computation and Storage of scientific data sets in cloud – Stream Data Model – Architecture for Data Stream Management – Stream Queries – Sampling Data in a Stream Filtering Streams.

UNIT – III	TECHNOLOGIES AND TECHNIQUES	(9)

Load balancing techniques for Data Intensive computing – Resource Management for Data Intensive Clouds – SALT – Parallel Processing – Multiprocessors and Virtualization in Data intensive Computing – Challenges in Data Intensive Analysis and Visualization – Large Scale Data Analytics Using Ensemble Clustering – Ensemble Feature Ranking Methods for Data Intensive Computing Application – Record Linkage Methodology and Applications Semantic Wrapper.

UNIT – IV	SECURITY	(9)

Security in Data Intensive Computing Systems – Data Security and Privacy in Data Intensive Supercomputing Clusters –Information Security in Large Scale Distributed Systems – Privacy and Security Requirements of Data Intensive Applications in Clouds.

UNIT – V	APPLICATIONS AND FUTURE TRENDS	(9)

Cloud and Grid Computing for Data Intensive Applications – Scientific Applications – Bioinformatics Large Science Discoveries – Climate Change – Environment – Energy – Commercial Applications – Future trends in Data Intensive Computing.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, the students will be able to:

COs	Course Outcome	Cognitive Level
CO1	Articulate key concepts and technologies related to distributed systems, such as Hadoop and NoSQL databases.	**Understand**
CO2	Develop architectures for high-performance data-intensive computing and storage solutions.	**Apply**
CO3	Implement techniques for load balancing and resource management in data-intensive environments.	**Apply**
CO4	Evaluate and apply security measures to protect data in computing systems.	**Apply**
CO5	Analyze current applications of data-intensive computing and assess future trends in the field.	**Understand**

REFERENCES:

1. Martin Kleppmann, "Designing Data-Intensive Applications", O'Reilly Media, USA, 1st Edition, 2017.
2. Tom White, "Hadoop: The Definitive Guide", O'Reilly Media, USA, 2nd Edition, 2010.
3. Hector Garcia-Molina, Jeffrey D. Ullman, and Jennifer Widom., "Database Systems: The Complete Book", Pearson, India, 2nd Edition, 2013.
4. Furht, Borko, Escalante, Armando, "Handbook of Data Intensive Computing", Springer, USA, 1st Edition, 2011.
5. https://www.computer.org/csdl/magazine/co/2008/04/mco20080 40030/13rRUNvgyZ8

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PSO1	PSO2
CO1	2	2	3	3	2
CO2	2	2	3	3	2
CO3	2	2	3	3	2
CO4	2	2	3	3	2
CO5	2	2	3	3	2
Avg.	**2**	**2**	**3**	**3**	**2**

1-low, 2-medium, 3-high

BD24E08	INTERNET OF THINGS (PROFESSIONAL ELECTIVES – III and IV)	Category	L	T	P	C
		PCC	3	0	0	3

(Common to M.E CSE and M.E BDA)

PREREQUISITE

Basic knowledge of computer networking, familiarity with Python programming, and experience with microcontroller platforms like Arduino or Raspberry Pi. Understanding of web technologies and cloud computing fundamentals.

OBJECTIVES:

1. To introduce the basics of IoT and its underlying technologies.
2. To review the development of IoT systems using popular hardware and software tools.
3. To explore various IoT communication protocols.
4. To study cloud services for IoT applications.
5. To learn Industrial IoT (IIoT) and its applications.

UNIT – I	INTRODUCTION TO INTERNET OF THINGS	(9)

Basic computer networking to Internet of things: Network Types – Layered network models – Addressing – TCP/IP transport Layer. Definition and Characteristics of IoT – Physical Design of IoT – Logical Design of IoT – IoT Enabling Technologies – IoT Levels and Deployment Templates – IoT and M2M.

UNIT – II	BUILDING IOT SYSTEMS	(9)

IoT Physical devices and Endpoints: Basic building blocks of IoT Device – Raspberry Pi – Linux on Raspberry Pi – Interfaces – Programming Raspberry Pi with Python – Python packages for IOT: JSON – XML – HTTPLib – URLLib – SMTPLib – XMPP – Contiki OS – Other IoT Platform: Arduino – Intel Galileo and Beaglebone boards.

UNIT – III	IOT PROTOCOLS	(9)

Introduction to IoT Protocols – 6LoWPAN – IEEE 802.11 – WiFi – 802.15 Bluetooth – 802.15.4 – Zigbee – CoAP.

UNIT – IV	CLOUD OFFERINGS AND IOT CASE STUDIES	(9)

Cloud Storage Models and Communication APIs for IoT– WAMP – Xively Cloud – Python Web Application framework – Designing a RESTful Web API – Amazon Web Services for IoT – MQTT – Case studies for IoT Design: Home automation – Smart Agriculture.

UNIT – V	INDUSTRIAL INTERNET OF THINGS (IIOT)	(9)

Introduction – Industrial Process – The Computer Integrated Manufacturing Pyramid (CIM) – IIoT data flow – Understanding the IIoT edge: Features of the edge – Architecture and implementations. Implementing IOT industrial solution with cloud services.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, the students will be able to:

COs	Course Outcome	Cognitive Level
CO1	Comprehend the fundamental concepts of IoT.	**Understand**
CO2	Build simple IoT systems using devices like Raspberry Pi.	**Apply**
CO3	Familiarize with key IoT communication protocols.	**Understand**
CO4	Develop cloud-integrated IoT applications.	**Apply**
CO5	Apply IIoT concepts in industrial scenarios.	**Apply**

REFERENCES:

1. Arshdeep Bahga, Vijay Madisetti, “Internet of Things: A hands-on Approach”, University Press, UK, 1st Edition, 2015.
2. Giacomo Veneri, Antonio Capasso, “Hands-On Industrial Internet of Things Create a Powerful Industrial IoT Infrastructure Using Industry 4.0”, Packt Publishing Ltd, UK, 1st Edition, 2018.
3. Adrian McEwen Hakim Cassimally, “Designing the Internet of Things", Wiley, India, 1st Edition, 2013.
4. Olivier Hersent, David Boswarthick, Omar Elloum, “The Internet of Things – Key applications and Protocols”, Wiley, India, 1st Edition, 2012.
5. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stamatis, Karnouskos, Stefan Avesand, David Boyle, “From Machine - to-Machine to the Internet of Things - Introduction to a New Age of Intelligence”, Academic Press, Elsevier Science, 1st Edition, 2014.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PSO1	PSO2
CO1	2	1	2	3	2
CO2	2	1	2	3	2
CO3	2	1	2	3	2
CO4	2	1	2	3	2
CO5	2	1	2	3	2
Avg.	**2**	**1**	**2**	**3**	**2**

CS24E09	FULL STACK WEB APPLICATION DEVELOPMENT (PROFESSIONAL ELECTIVES – III and IV)	Category	L	T	P	C
		PEC	3	0	0	3

(Common to M.E CSE and M.E BDA)

PREREQUISITE

Students should have a fundamental understanding of web development concepts and programming basics. Familiarity with core programming languages such as JavaScript is essential, as well as a basic grasp of HTML and CSS.

OBJECTIVES:

1. To gain proficiency in JavaScript and TypeScript for developing dynamic web applications.
2. To build and manage Angular components and data binding effectively.
3. To learn Node.js for building scalable and efficient server-side applications.
4. To configure and use Express.js for streamlined web application development.
5. To manage and integrate MongoDB with Node.js for effective data handling and storage.

UNIT – I	JAVASCRIPT AND TYPESCRIPT LANGUAGE	(9)

Server-Side Web Applications – Client-Side Web Applications – Understanding JavaScript: Types – Working with Arrays – Working with Objects – Understanding JavaScript Object Inheritance – Adding Type Declarations for the JavaScript Package – Adding Commands – Persistently Storing. Typescript: Data Types – Classes – Interfaces – Modules – Enumerations and Generics – Constructors – Functions – Getters and Setters.

UNIT – II	ANGULAR	(9)

Angular CLI – Anatomy of a Component – Data Binding: One Way Data Binding –Two Way Data Binding – Event Handling – Angular Module System – Directives – Types of Directives – Accessing the DOM Events in Directives Accessing the DOM Properties in Directives – Component Class Lifecycle.

UNIT – III	NODE.js	(9)

Basics of Node JS – Installation – Working with Node packages – Using Node package manager – Creating a simple Node.js application – Using Events – Listeners –Timers – Callbacks – Handling Data I/O – Implementing HTTP services in Node.js – Implementing Socket Services in Node.js.

UNIT – IV	EXPRESS.Js	(9)

Express.js: How Express.js Works. Configuration, Settings and Environment Middleware – Body Parser – Cookie –Parser – Express-session – Response time – Template Engine – Parameters and Routing – Router Class – Request Object – Response Object – Error Handling.

UNIT – V	MONGODB	(9)

Understanding NoSQL and MongoDB – Building MongoDB Environment – Administering User Accounts – Configuring Access control – Administering databases – Managing collections – Connecting to MongoDB from Node.js – Understanding the Objects Used in the MongoDB Node.js Driver – Accessing and Manipulating Databases – Manipulating MongoDB Documents from Node.js.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, the students will be able to:

COs	Course Outcome	Cognitive Level
CO1	Infer in-depth knowledge of key features and data types for efficient web development.	**Understand**
CO2	Develop and manage Angular applications with skill.	**Understand**
CO3	Utilize Node.js for server-side development and handling various server-side tasks and services.	**Apply**
CO4	Construct and set up web applications with Express.js.	**Apply**
CO5	Integrate MongoDB with Node.js to manage data effectively in real-world applications.	**Apply**

REFERENCES:

1. Brad Dayley, Brendan Dayley, Caleb Dayley, "Node.js, MongoDB and Angular Web Development", Addison-Wesley, United States, 2nd Edition, 2018.
2. Adam Freeman, "Essential Typescript, Apress, United States, 1st Edition, 2019.
3. Mark Clow, "Angular Projects", Apress, United States, 1st Edition,2018.
4. Azat Mardan, "Pro Express.js", Apress, United States, 1st Edition,2015.
5. Chris Northwood, "The Full Stack Developer: Your Essential Guide to the Everyday Skills Expected of a Modern Full Stack Web Developer", Apress, 1st Edition, 2018.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PSO1	PSO2
CO1	2	3	3	3	2
CO2	2	3	3	3	2
CO3	2	3	3	3	2
CO4	2	3	3	3	2
CO5	2	3	3	3	2
Avg.	**2**	**3**	**3**	**3**	**2**

1-low, 2-medium, 3-high

CS24E10	DEEP LEARNING (PROFESSIONAL ELECTIVES – III and IV)	Category	L	T	P	C
		PEC	3	0	0	3

(Common to M.E CSE and M.E BDA)

PREREQUISITE

Students should have a strong foundation in programming, preferably in Python, which is widely used in the field. A solid understanding of mathematics, including linear algebra, calculus and probability is essential for grasping deep learning algorithms and techniques.

OBJECTIVES:

1. To gain foundational knowledge of deep learning concepts, algorithms, and data types.
2. To acquire skills in building and optimizing neural networks.
3. To develop expertise in designing and implementing CNNs for image processing and transfer learning.
4. To learn techniques for NLP using Recurrent Neural Networks (RNNs) and LSTM and GRU.
5. To study the techniques like Q-Learning, GANs, and autoencoders.

UNIT– I	BASICS OF DEEP LEARNING	(9)

Fundamentals about Deep Learning – Perception Learning Algorithms – Probabilistic modelling – Early Neural Networks – Different from Deep Learning and Machine Learning – Scalars – Vectors – Matrixes – Higher Dimensional Tensors – Manipulating Tensors – Vector Data – Time Series Data – Image Data –Video Data.

UNIT – II	NEURAL NETWORKS	(9)

Fundamentals of Neural Network – Building Blocks of Neural Network – Optimizers. Activation Functions – Loss Functions – Data Pre-processing for neural networks – Feature Engineering – Overfitting and Underfitting – Hyperparameters.

UNIT – III	CONVOLUTIONAL NEURAL NETWORK	(9)

Introduction of CNN – Linear Time Invariant – Image Processing Filtering – Building a convolutional neural network – Input Layers – Convolution Layers – Pooling Layers – Dense Layers – Backpropagation Through the Convolutional Layer – Filters and Feature Maps – Backpropagation Through the Pooling Layers – Transfer Learning with Image Data – Transfer Learning using Inception Oxford VGG Model – Google Inception Model.

UNIT – IV	NATURAL LANGUAGE PROCESSING USING RNN	(9)

NLP and its Toolkits – Language Modeling – Vector Space Model (VSM) – Continuous Bag of Words (CBOW) –Skip-Gram Model for Word Embedding – Global Vectors for Word Representation GloVe – Backpropagation Through Time – Bidirectional RNNs (BRNN) – Long Short-Term Memory (LSTM) – Bi-directional LSTM – Sequence-to-Sequence Models – Gated recurrent unit GRU.

UNIT – V	DEEP REINFORCEMENT AND UNSUPERVISED LEARNING	(9)

Deep Reinforcement Learning – Q-Learning – Deep Q-Network (DQN) – Policy Gradient Methods – Actor-Critic Algorithm – Autoencoding – Convolutional Auto Encoding – Variational Auto Encoding – Generative Adversarial Networks – Autoencoders for Feature Extraction – Auto Encoders for Classification – Denoising Autoencoders – Sparse Autoencoders.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, the students will be able to:

COs	Course Outcome	Cognitive Level
CO1	Demonstrate proficiency in deep learning principles and the ability to manage various data types.	**Understand**
CO2	Build and fine-tune neural networks using various activation and loss functions.	**Understand**
CO3	Develop and use convolutional neural networks for image-related tasks and transfer learning.	**Apply**
CO4	Apply RNNs, LSTM, and GRU models for processing and modeling language data.	**Apply**
CO5	Implement reinforcement learning methods and unsupervised techniques for data analysis and generation.	**Apply**

REFERENCES:

1. Brad Dayley, Josh Patterson and Adam Gibson, "Deep Learning A Practitioner's Approach", O'Reilly Media, USA, 1st Edition, 2017.
2. Jojo Moolayil, "Learn Keras for Deep Neural Networks", Apress, Canada, 1st Edition, 2018.
3. Vinita Silaparasetty, "Deep Learning Projects Using TensorFlow 2", Apress, Canada, 1st Edition, 2020.
4. Francois Chollet, "Deep Learning with Python", Manning Shelter Island, 2nd Edition,2017.
5. Santanu Pattanayak, "Pro Deep Learning with TensorFlow", Apress, Canada, 1st Edition, 2017.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	2	2	3	3
CO2	3	2	2	3	3
CO3	3	2	2	3	3
CO4	3	2	2	3	3
CO5	3	2	2	3	3
Avg.	**3**	**2**	**2**	**3**	**3**

1-low, 2-medium, 3-high

BD24E09	BLOCKCHAIN TECHNOLOGIES (PROFESSIONAL ELECTIVES – III and IV)	Category	L	T	P	C
		PEC	3	0	0	3

(Common to M.E CSE and M.E BDA)

PREREQUISITE

A foundational knowledge of cryptography and hashing algorithms is essential. Familiarity with basic concepts in distributed systems and databases will also be beneficial. Understanding the principles of digital currencies and financial transactions will further aid in grasping blockchain applications.

OBJECTIVES:

1. To learn the basics of blockchain technology and its applications.
2. To study the architecture and types of cryptocurrencies.
3. To explore mechanisms to prevent double spending.
4. To gain insights into Bitcoin's key concepts and practical use.
5. To acquire about Ethereum, smart contracts, and blockchain applications.

UNIT – I	BASICS OF BLOCKCHAIN	(9)

Introduction to Blockchain – How Blockchain works – Blockchain vs Bitcoin – Practical applications – Public and Private key basics – Pros and Cons of Blockchain – Myths about Bitcoin.

UNIT – II	BLOCKCHAIN AND CRYPTOCURRENCIES	(9)

Architecture – Versions – Variants – Use cases – Life use cases of blockchain – Blockchain Vs Shared Database – Introduction to cryptocurrencies –Types – Applications.

UNIT – III	CONCEPT OF DOUBLE SPENDING	(9)

Concept of Double Spending – Hashing – Mining – Proof of work. Introduction to Merkel tree – Privacy – Payment verification –Resolving Conflicts – Creation of Blocks.

UNIT– IV	BITCOIN	(9)

Introduction to Bitcoin – key concepts of Bitcoin – Merits and De Merits Fork and Segwits – Sending and Receiving bitcoins – Choosing bitcoin wallet – Converting Bitcoins to Fiat Currency.

UNIT – V	ETHEREUM AND BLOCKCHAIN APPLICATION	(9)

Introduction to Ethereum – Advantages and Disadvantages – Ethereum vs Bitcoin – Introduction to Smart contracts – usage – Application – Working principle – Law and Regulations. Application: Medical Record Management System, Domain Name Service and Future of Blockchain.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

COs	Course Outcome	Cognitive Level
CO1	Comprehend blockchain fundamentals and its practical uses.	**Understand**
CO2	Apply knowledge of cryptocurrency architecture and types in real-world scenarios.	**Apply**
CO3	Identify methods for preventing double spending and their effectiveness.	**Understand**
CO4	Elucidate Bitcoin's advantages, disadvantages, and transaction processes.	**Apply**
CO5	Build applications using Ethereum and smart contracts, considering legal and regulatory aspects.	**Understand**

REFERENCES:

1. Bikramaditya Signal, Gautam Dhameja, Priyansu Sekhar Panda, "Beginning Blockchain: A Beginner's Guide to Building Blockchain Solutions", APress, USA, 1st Edition, 2018,
2. Bahga, Vijay Madisetti, "Blockchain Applications: A Hands-On Approach", Arshdeep Bahga, USA, 1st Edition, 2018,
3. Alan Wright, "Blockchain - Hardcover Version: Uncovering Blockchain Technology, Cryptocurrencies, Bitcoin and the Future of Money", House of Books, Manchester, 1st Edition, 2021.
4. Arvind Narayanan & Joseph Bonneau & Edward Felten & Andrew Miller & Steven Goldfeder, "Bitcoin and Cryptocurrency Technologies", Princeton University Press, USA,1st Edition, 2016.
5. Andreas M. Antonopoulos, "Mastering Bitcoin Unlocking Digital Cryptocurrencies", Oreilly, USA, 1st Edition, 2014.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	1	3	3	1
CO2	3	1	3	3	1
CO3	3	1	3	3	1
CO4	3	1	3	3	1
CO5	3	1	3	3	1
Avg.	**3**	**1**	**3**	**3**	**1**

1-low, 2-medium, 3-high

CS24E11	NATURAL LANGUAGE PROCESSING (PROFESSIONAL ELECTIVES – III and IV)	Category	L	T	P	C
		PEC	3	0	0	3

(Common to M.E CSE and M.E BDA)

PREREQUISITE

Knowledge of fundamental linguistic concepts such as syntax, semantics, and morphology. Proficiency in Python or another programming language used in NLP and Basic understanding of machine learning principles and algorithms.

OBJECTIVES:

1. To gain foundational knowledge of natural language processing (NLP) and its components.
2. To study statistical methods for text classification and sequence labeling.
3. To develop skills in parsing and dependency parsing using contextual embeddings.
4. To learn semantic role labeling, word sense disambiguation, and information extraction techniques.
5. To review methods for discourse analysis, question answering, and dialogue system development.

UNIT – I	BASICS OF NLP	(9)

Natural Language Processing – Components – Basics of Linguistics and Probability and Statistics – Words – Tokenization – Morphology – Finite State Automata

UNIT – II	STATISTICAL NLP AND SEQUENCE LABELING	(9)

N-grams and Language models – Smoothing –Text classification – Naïve Bayes classifier – Evaluation – Vector Semantics – TF – IDF – Word2Vec- Evaluating Vector Models – Sequence Labeling – Part of Speech – Part of Speech Tagging – Named Entities – Named Entity Tagging.

UNIT – III	CONTEXTUAL EMBEDDING	(9)

Constituency – Context Free Grammar – Lexicalized Grammars – CKY Parsing – Earley's Algorithm – Evaluating Parsers – Partial Parsing – Dependency Relations – Dependency Parsing -–Transition Based – Graph Based.

UNIT – IV	COMPUTATIONAL SEMANTICS	(9)

Word Senses and WordNet – Word Sense Disambiguation – Semantic Role Labeling – Proposition Bank – FrameNet – Selectional Restrictions – Information Extraction – Template Filling.

UNIT – V	DISCOURSE ANALYSIS AND SPEECH PROCESSING	(9)

Discourse Coherence – Discourse Structure Parsing – Centering and Entity Based Coherence – Question Answering –Factoid Question Answering – Classical QA Models – Chatbots and Dialogue systems – Frame-based Dialogue Systems – Dialogue – State Architecture.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, the students will be able to:

COs	Course Outcome	Cognitive Level
CO1	Demonstrate comprehension of NLP basics, linguistics, and tokenization techniques.	**Understand**
CO2	Implement statistical models for text classification, sequence labeling and vector semantics evaluation.	**Apply**
CO3	Develop and apply parsing techniques and contextual embeddings for sentence structure analysis.	**Apply**
CO4	Analyze and apply techniques for word sense disambiguation and semantic role labeling.	**Apply**
CO5	Determine and develop discourse analysis models and dialogue systems, including question answering and chatbots.	**Understand**

REFERENCES:

1. Daniel Jurafsky and James H.Martin, "Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition", Prentice Hall, India, 2nd Edition, 2020
2. Jacob Eisenstein, "Natural Language Processing", MIT Press, USA, 1st Edition, 2019
3. Samuel Burns, "Natural Language Processing: A Quick Introduction to NLP with Python and NLTK", 1st Edition, 2019
4. Nitin Indurkhya,Fred J. Damerau, "Handbook of Natural Language Processing", Chapman & Hall/CRC: Machine Learning & Pattern Recognition, Hardcover, 2nd Edition, 2010
5. Deepti Chopra, Nisheeth Joshi, "Mastering Natural Language Processing with Python", Packt Publishing Limited, Mumbai, 1st Edition, 2016

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	3	2	3	2
CO2	3	3	2	3	2
CO3	3	3	2	3	2
CO4	3	3	2	3	2
CO5	3	3	2	3	2
Avg.	**3**	**3**	**2**	**3**	**2**

1-low, 2-medium, 3-high

BD24E10	CYBER PHYSICAL SYSTEMS (PROFESSIONAL ELECTIVES – III and IV)	Category	L	T	P	C
		PEC	3	0	0	3

(Common to M.E CSE and M.E BDA)

PREREQUISITE
Basic understanding of embedded systems and control theory, as well as knowledge of computer networking and communication protocols. Awareness with real-time operating systems and scheduling algorithms and system design is essential, along with a foundation in verification techniques and security concepts.

OBJECTIVES:
1. To introduce the emergence and significance of CPS.
2. To learn methods for ensuring safety and liveness in CPS.
3. To investigate different models and protocols for designing CPS.
4. To study foundational aspects like security and synchronization in CPS.
5. To explore practical CPS applications using tools like CyberSim, Matlab, and Simulink.

UNIT – I	BASICS OF CYBER-PHYSICAL SYSTEMS	(9)

Cyber-Physical Systems (CPS) – Emergence of CPS – Key Features of Cyber-Physical Systems – CPS Drivers –Synchronous Model: Reactive Components – Properties of Components – Composing Components – Designs – Asynchronous Model of CPS: Processes – Design Primitives – Coordination Protocols.

UNIT – II	CPS REQUIREMENTS	(9)

Safety Specifications: Specifications – Verifying Invariants – Enumerative Search – Symbolic Search – Liveness Requirements: Temporal Logic – Model Checking – Proving Liveness.

UNIT – III	CPS MODELS	(9)

Dynamical Systems: Continuous – Linear Systems –Time Models – Linear Systems – Designing Controllers – Analysis Techniques – Timed Model: Processes – Protocols – Automata – Hybrid Dynamical Models.

UNIT – IV	CPS FOUNDATIONS	(9)

Symbolic Synthesis for CPS – Security in CPS – Synchronization of CPS – Real-Time Scheduling for CPS.

UNIT – V	APPLICATIONS AND PLATFORMS	(9)

Medical CPS – CPS Built on Wireless Sensor Networks – CyberSim User Interface – iClebo Kobuki – iRobot Create –myRIO – Cybersim – Matlab toolboxes – Simulink.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, the students will be able to:

COs	Course Outcome	Cognitive Level
CO1	Comprehend the key features and drivers of Cyber-Physical Systems (CPS).	**Understand**
CO2	Examine synchronous and asynchronous models in CPS design.	**Understand**
CO3	Apply safety and liveness requirements to verify CPS behavior.	**Apply**
CO4	Design and apply continuous, linear, and hybrid dynamical systems for CPS.	**Apply**
CO5	Explore real-time scheduling, security and synchronization in CPS.	**Understand**

REFERENCES:

1. Raj Rajkumar, Dionisio De Niz, and Mark Klein, "Cyber-Physical Systems", Addison Wesley Professional, USA, 2016
2. Rajeev Alur, "Principles of Cyber-Physical Systems", MIT Press, USA, 1st Edition, 2015.
3. Lee, Edward Ashford, and Sanjit Arunkumar Seshia, "Introduction to embedded systems: A cyber physical systems approach", 2nd Edition, 2017
4. André Platzer, "Logical Analysis of Hybrid Systems: Proving Theorems for Complex Dynamics", Springer, USA, 1st Edition, 2010.
5. Jean J. Labrosse, "Embedded Systems Building Blocks: Complete and Ready-To-Use Modules in C", The publisher, Paul Temme, 1st Edition, 2011.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	1	3	2	1
CO2	3	1	3	2	1
CO3	3	1	3	2	1
CO4	3	1	3	2	1
CO5	3	1	3	2	1
Avg.	**3**	**1**	**3**	**2**	**1**

1-low, 2-medium, 3-high

BD24E11	IMAGE AND VIDEO ANALYTICS (PROFESSIONAL ELECTIVES – III and IV)	Category	L	T	P	C
		PEC	3	0	0	3

PREREQUISITE

A basic understanding of computer vision, image processing, and machine learning algorithms. Familiarity with Python and libraries like OpenCV or TensorFlow is essential. Additionally, knowledge of neural networks and video processing techniques.

OBJECTIVES:

1. To study core principles in image representation and analysis techniques.
2. To get the knowledge on image pre-processing methods and their use in enhancing images.
3. To investigate object detection strategies and deep learning models for precise detection.
4. To learn and develop face and gesture recognition systems using cutting-edge deep learning technologies.
5. To gain insights into video analytics, focusing on contemporary architectures and their applications in video data processing.

UNIT – I	BASICS OF IMAGE AND VIDEO ANALYTICS	(9)

Computer Vision – Image representation and image analysis tasks – Image representations – Digitization – Properties – Color images – Linear integral transforms – Data structures for Image Analysis – Levels of image data representation – Traditional and Hierarchical image data structures.

UNIT – II	IMAGE PRE-PROCESSING	(9)

Local pre-processing – Image smoothing – Edge detectors – Zero-crossings of the second derivative – Scale in image processing – Canny edge detection – Parametric edge models – Local pre-processing in the frequency domain – Line detection by local pre-processing operators – Image restoration.

UNIT – III	OBJECT DETECTION USING MACHINE LEARNING	(9)

Object detection – Object detection methods – Deep Learning framework for Object detection – Bounding box approach – Intersection over Union (IoU) – Deep Learning Architectures – R-CNN – Faster R-CNN – You Only Look Once (YOLO) – Salient features – Loss Functions – YOLO architectures.

UNIT – IV	FACE RECOGNITION AND GESTURE RECOGNITION	(9)

Face Recognition – Introduction – Applications of Face Recognition – Process of Face Recognition – Deep Face solution by Facebook – FaceNet for Face Recognition – Implementation using Face Net – Gesture Recognition.

UNIT – V	VIDEO ANALYTICS	(9)

Video Processing – Use cases of video analytics – Vanishing Gradient and exploding gradient problem – ResNet architecture – ResNet and skip connections – Inception Network – Google Net architecture – Improvement in Inception v2 – Video analytics – ResNet and Inception v3.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, the students will be able to:

COs	Course Outcome	Cognitive Level
CO1	Illustrate image representation, analysis tasks, and data structures in computer vision.	**Understand**
CO2	Apply image pre-processing techniques including edge detection and image restoration.	**Apply**
CO3	Implement object detection methods using deep learning frameworks such as R-CNN and YOLO.	**Apply**
CO4	Develop face and gesture recognition systems using deep learning techniques.	**Apply**
CO5	Discover video processing techniques and architectures like ResNet and Inception for video analytics.	**Apply**

REFERENCES:

1. Milan Sonka, Vaclav Hlavac, Roger Boyle, "Image Processing, Analysis, and Machine Vision", Cengage India Private Limited, India, 4th Edition, 2017.
2. Vaibhav Verdhan, "Computer Vision Using Deep Learning Neural Network Architectures with Python and Keras", Apress, India, 1st Edition, 2021.
3. Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer Verlag London Limited, India, 2nd Edition, 2022.
4. Caifeng Shan, Fatih Porikli, Tao Xiang, Shaogang Gong, "Video Analytics for Business Intelligence", Springer, India, 1st Edition, 2012.
5. D. A. Forsyth, J. Ponce, "Computer Vision: A Modern Approach", Pearson Education, London, 2nd Edition, 2015.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PSO1	PSO2
CO1	1	3	3	2	1
CO2	1	3	3	2	1
CO3	1	3	3	2	1
CO4	1	3	3	2	1
CO5	1	3	3	2	1
Avg.	**1**	**3**	**3**	**2**	**1**

CS24E13	QUANTUM COMPUTING (PROFESSIONAL ELECTIVES – III and IV)	Category	L	T	P	C
		PEC	3	0	0	3

(Common to M.E CSE and M.E BDA)

PREREQUISITE

A strong foundation in linear algebra, probability theory, and complex numbers. Familiarity with basic quantum mechanics and classical computing concepts is essential. Programming knowledge in quantum computing frameworks like Qiskit or Cirq.

OBJECTIVES:

1. To study basic quantum mechanics and qubit systems.
2. To learn quantum state transformations and quantum gates.
3. To explore key quantum algorithms and their generalizations.
4. To study quantum error correction and fault-tolerant computation techniques.
5. To investigate quantum cryptography, teleportation, and quantum information protocols.

UNIT – I	QUANTUM BUILDING BLOCKS	(9)

The Quantum Mechanics of Photon Polarization – Single-Qubit Quantum Systems – Quantum State Spaces – Entangled States – Multiple-Qubit Systems – Measurement of Multiple-Qubit States – EPR Paradox and Bell's Theorem – Bloch sphere.

UNIT – II	QUANTUM STATE TRANSFORMATIONS	(9)

Unitary Transformations – Quantum Gates – Unitary Transformations as Quantum Circuits – Reversible Classical Computations to Quantum Computations – Language for Quantum Implementations.

UNIT – III	QUANTUM ALGORITHMS	(9)

Computing with Superpositions – Quantum Subroutines – Quantum Fourier Transformations – Shor's Algorithm and Generalizations – Grover's Algorithm and Generalizations.

UNIT – IV	ENTANGLED SUBSYSTEMS AND ROBUST QUANTUM COMPUTATION	(9)

Quantum Subsystems – Properties of Entangled States – Quantum Error Correction – Graph states and codes – CSS Codes – Stabilizer Codes – Fault Tolerance and Robust Quantum Computing.

UNIT – V	QUANTUM INFORMATION PROCESSING	(9)

Limitations of Quantum Computing – Alternatives to the Circuit Model of Quantum Computation – Quantum Protocols – Building Quantum – Computers, Simulating Quantum Systems, Bell states. Quantum teleportation – Quantum Cryptography – No cloning theorem.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

COs	Course Outcome	Cognitive Level
CO1	Infer the fundamental concepts of quantum mechanics and qubit systems.	**Understand**
CO2	Apply quantum gates and unitary transformations to quantum circuits.	**Apply**
CO3	Implement quantum algorithms such as Shor's and Grover's algorithms.	**Apply**
CO4	Make use of quantum error correction methods and fault-tolerant quantum computing.	**Apply**
CO5	Discover quantum protocols, cryptography, and the no-cloning theorem in quantum information processing.	**Understand**

REFERENCES:

1. John Gribbin, "Computing with Quantum Cats: From Colossus to Qubits", Bantam Press, New York, 3rd Edition, 2021.
2. William (Chuck) Easttom, "Quantum Computing Fundamentals", Addison-Wesley Professional, USA, 1st Edition, 2021.
3. Parag Lala, "Quantum Computing", McGraw-Hill Education, India, 1st Edition, 2019
4. Eleanor Rieffel and Wolfgang Polak, "Quantum Computing A Gentle Introduction", MIT Press, USA, 1st Edition, 2011.
5. Nielsen M. A., "Quantum Computation and Quantum Information", Cambridge University Press, England, 1st Edition, 2002.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PSO1	PSO2
CO1	1	2	3	2	1
CO2	1	2	3	2	1
CO3	1	2	3	2	1
CO4	1	2	3	2	1
CO5	1	2	3	2	1
Avg.	**1**	**2**	**3**	**2**	**1**

1-low, 2-medium, 3-high

BD24E12	INFORMATION RETRIEVAL TECHNIQUES (PROFESSIONAL ELECTIVES – III and IV)	Category	L	T	P	C
		PEC	3	0	0	3

(Common to M.E CSE and M.E BDA)

PREREQUISITE

A foundational knowledge of data structures and algorithms, especially related to search and sorting techniques. Familiarity with basic probability, statistics, and machine learning concepts is essential for understanding classification, clustering, and retrieval models. Knowledge of web technologies and experience in programming languages like Python or Java will be beneficial for implementing IR systems.

OBJECTIVES:

1. To learn the foundational concepts and practical challenges in Information Retrieval (IR).
2. To study and analyze different IR models and their practical applications.
3. To learn various indexing methods and strategies for efficient query processing.
4. To gain the principles of text classification and clustering using advanced algorithms.
5. To explore the web search process, link analysis, and multimedia IR methods for enhanced retrieval.

UNIT – I	MOTIVATION	(9)

Basic Concepts – Practical Issues – Retrieval Process – Architecture – Boolean Retrieval – Retrieval Evaluation – Open-Source IR Systems – History of Web Search – Web Characteristics – Impact of the web on IR – IR Versus Web Search – Components of a Search Engine.

UNIT – II	MODELING	(9)

Taxonomy and Characterization of IR Models – Boolean Model – Vector Model – Term Weighting – Scoring and Ranking – Language Models – Set Theoretic Models – Probabilistic Models – Algebraic Models – Structured Text Retrieval Models – Models for Browsing.

UNIT – III	INDEXING	(9)

Static and Dynamic Inverted Indices – Index Construction and Index Compression. Searching – Sequential Searching and Pattern Matching – Query Operations – Query Languages – Query Processing – Relevance Feedback and Query Expansion – Automatic Local and Global Analysis – Measuring Effectiveness and Efficiency.

UNIT – IV	CLASSIFICATION AND CLUSTERING	(9)

Text Classification and Naive Bayes – Vector Space Classification – Support Vector Machines and Machine Learning on Documents. Flat Clustering – Hierarchical Clustering – Matrix Decompositions and Latent Semantic Indexing – Fusion and Meta Learning.

UNIT – V	SEARCHING THE WEB	(9)

Searching the Web – Structure of the Web – IR and web search – Static and Dynamic Ranking – Web Crawling and Indexing – Link Analysis – XML Retrieval Multimedia IR: Models and Languages – Indexing and Searching Parallel and Distributed IR – Digital Libraries.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, the students will be able to:

COs	Course Outcome	Cognitive Level
CO1	Understand the architecture and process of Information Retrieval (IR) systems.	**Understand**
CO2	Apply different IR models like Boolean, Vector, and Probabilistic models.	**Apply**
CO3	Implement indexing techniques, including static and dynamic inverted indices.	**Apply**
CO4	Perform text classification and clustering using machine learning methods.	**Understand**
CO5	Discover web search processes, web crawling, and multimedia IR techniques.	**Understand**

REFERENCES:

1. Ricardo Baeza, Yates, Berthier Ribeiro and Neto, "Modern Information Retrieval: The concepts and Technology behind Search", ACM Press Books, New York, 2nd Edition, 2011.
2. Stefan Buttcher, Charles L. A. Clarke and Gordon V. Cormack, "Information Retrieval Implementing and Evaluating Search Engines", The MIT Press, Cambridge, Massachusetts London, England, 3rd Edition, 2010.
3. Christopher D. Manning, Prabhakar Raghavan and Hinrich Schutze, "Introduction to Information Retrieval", Cambridge University Press, US, 1st Edition, 2008.
4. Gerald J. Kowalski, Mark T. Maybury, "Information Storage and Retrieval Systems: Theory and Implementation", Springer, US, 6th Edition, 2013.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PSO1	PSO2
CO1	1	1	1	3	2
CO2	1	1	1	3	2
CO3	1	1	1	3	2
CO4	1	1	1	3	2
CO5	1	1	1	3	2
Avg.	**1**	**1**	**1**	**3**	**2**

1-low, 2-medium, 3-high

BD24E13	WEB ANALYTICS (PROFESSIONAL ELECTIVES – III and IV)	Category	L	T	P	C
		PEC	3	0	0	3

PREREQUISITE

A foundational understanding of web technologies and data structures. Familiarity with basic statistical methods and analytical techniques is essential for interpreting web metrics. Experience with data collection and analysis tools, such as Google Analytics.

OBJECTIVES:

1. To study the evolution and current challenges in web analytics.
2. To establish practical solutions for analyzing clickstream data and metrics.
3. To investigate competitive intelligence methods for traffic and audience insights.
4. To learn techniques for analyzing social, mobile, and video analytics.
5. To gain the solutions for improving accuracy and handling data quality in web analytics.

UNIT – I	INTRODUCTION TO WEB ANALYTICS	(9)

Web Analytics – Present and Future: A Brief History of Web Analytics – Current Landscape and Challenges –Traditional Web Analytics Is Dead – What Web Analytics Should Be Data Collection – Importance and Options: Understanding the Data Landscape – Click stream Data – Outcomes Data – Research Data – Competitive Data.

UNIT – II	WORLD OF CLICKSTREAM ANALYSIS METRICS AND PRACTICAL SOLUTIONS	(9)

Standard Metrics Revisited: Eight Critical Web Metrics – Bounce Rate-Exit Rate-Conversion Rate – Web Metrics Demystified – Strategically-aligned Tactics for Impactful Web Metrics – Web Analytics Primer-Foundational Analytical Strategies – Everyday Clickstream Analyses Made Actionable.

UNIT – III	COMPETITIVE INTELLIGENCE ANALYSIS	(9)

CI Data Sources – Types and Secrets – Website Traffic Analysis – Search and Keyword Analysis – Audience Identification and Segmentation Analysis

UNIT – IV	EMERGING ANALYTICS: SOCIAL, MOBILE AND VIDEO	(9)

Measuring the New Social Web: The Data Challenge – Analyzing Offline Customer Experiences – Analyzing Mobile Customer Experiences – Measuring the Success of Blogs – Quantifying the Impact of Twitter – Analyzing Performance of Videos.

UNIT – V	OPTIMAL SOLUTIONS FOR HIDDEN WEB ANALYTICS TRAPS	(9)

Accuracy and Precision – A Six-Step Process for Dealing with Data Quality – Building the Action Dashboard – Nonline Marketing Opportunity and Multichannel Measurement –The Promise and Challenge of Behaviour Targeting – Online Data Mining and Predictive Analytics: Challenges – Path to Nirvana: Steps Toward Intelligent Analytics Evolution.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, the students will be able to:

COs	Course Outcome	Cognitive Level
CO1	Comprehend the history and current challenges of web analytics.	**Understand**
CO2	Apply key web metrics to analyze clickstream data effectively.	**Apply**
CO3	Investigate competitive intelligence data for traffic and audience insights.	**Understand**
CO4	Identify social, mobile, and video analytics for performance measurement.	**Apply**
CO5	Develop solutions for improving accuracy and precision in web analytics.	**Apply**

REFERENCES:

1. Avinash Kaushik, "Web Analytics an Hour a Day", Publisher(s): Sybex, United States, 1st Edition, 2007.
2. Avinash Kaushik, "Web Analytics 2.0: The Art of Online Accountability and Science of Customer Centricity", John Wiley & Sons, New Jersey, 1st Edition, 2009.
3. Jason Burby and Shane Atchison, "Actionable Web Analytics: Using Data to Make Smart Business Decisions" Publisher(s): Sybex, United States, 1st Edition, 2007.
4. Eric T. Peterson, "Web Analytics Demystified: A Marketer's Guide to Understanding How Your Web Site Affects Your Business", Celilo Group Media, Portland, 1st Edition, 2004.
5. Michael Beasley, "Practical Web Analytics for User Experience", Morgan Kaufmann, United States, 1st Edition, 2013.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	1	2	3	1
CO2	3	1	2	3	1
CO3	3	1	2	3	1
CO4	3	1	2	3	1
CO5	3	1	2	3	1
Avg.	**3**	**1**	**2**	**3**	**1**