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	To become a globally renowned institution in engineering and management, committed to providing holistic education that fosters research, innovation and sustainable development.

Mission of the Institution

IM 1	Deliver value-based quality education through modern pedagogy and experiential learning.
IM 2	Enrich engineering and managerial skills through cutting-edge laboratories to meet evolving global demands.
IM 3	Empower research and innovation by integrating collaboration, social responsibility, and commitment to sustainable development.

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

DV	To produce globally competent researchers and innovators in Computer Science and Engineering, committed to ethical values and sustainable development.

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

DM 1	Provide high-quality learner-centric education in computer science and engineering through experiential learning and modern pedagogy.
DM 2	Enhance holistic, value-driven education through state-of-the-art laboratory facilities to meet global industry demand.
DM 3	Promote interdisciplinary innovation and research committed to sustainable development.

Program Educational Objectives (PEOs): (Computer Science and Engineering**)**

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.

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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.

Program Outcomes (POs) of M.E. - Computer Science and Engineering

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.
PO4	Apply the knowledge of computer system design principles in building system software and hardware components.
PO5	Apply the theoretical foundations of computer science in modeling and developing solutions to the real-world problems.

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	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 / Semester					Credit	Max. Marks		
				L	T	P	SL	Tot	C = T/30	CA	ES	Tot
Induction Programme			-	-	-	-	-	-	-	-	-	
THEORY COURSES												
1	MA24T16	Operations Research	FC	45	0	0	45	90	3	40	60	100
2	CS24T16	Advanced Data Structures and Algorithms	PCC	45	0	0	45	90	3	40	60	100
3	CS24T17	Database Practices	PCC	45	0	0	45	90	3	40	60	100
4	BD24T16	Foundations of Data Science	PCC	45	0	0	45	90	3	40	60	100
5		Professional Elective - I	PEC	45	0	0	45	90	3	40	60	100
6		Professional Elective - II	PEC	45	0	0	45	90	3	40	60	100
LABORATORY COURSES												
7	CS24P16	Advanced Data Structures and Algorithms Laboratory	PCC	0	0	60	0	60	2	60	40	100
8	BD24P11	Foundations of Data Science Laboratory	PCC	0	0	60	0	60	2	60	40	100
			TOTAL	**270**	**0**	**120**	**270**	**660**	**22**	**800**		

SEMESTER II

S. No.	Course Code	Course Title	Category	Periods / Semester					Credit	Max. Marks		
				L	T	P	SL	Tot	C = T/30	CA	ES	Tot
THEORY COURSES												
1	RM24T09	Research Methodology and IPR	RMC	45	0	0	45	90	3	40	60	100
2	BD24T26	Big Data Mining and Analytics	PCC	45	0	0	45	90	3	40	60	100
3	CS24T27	Cloud Computing	PCC	45	0	0	45	90	3	40	60	100
4	BD24T27	Machine Learning Techniques	PCC	45	0	0	45	90	3	40	60	100
5		Professional Elective - III	PEC	45	0	0	45	90	3	40	60	100
6		Professional Elective - IV	PEC	45	0	0	45	90	3	40	60	100

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LABORATORY COURSES												
7	BD24P26	Big Data Mining and Analytics Laboratory	PCC	0	0	60	0	60	2	60	40	100
8	CS24P26	Cloud Computing Laboratory	PCC	0	0	60	0	60	2	60	40	100
9	BD24P21	Technical Presentation	EEC	0	0	60	0	60	2	60	40	100
TOTAL				**270**	**0**	**180**	**270**	**720**	**24**	**900**		

SEMESTER III

S. No.	Course Code	Course Title	Category	Periods / Semester					Credit	Max. Marks		
				L	T	P	SL	Tot	C = T/30	CA	ES	Tot
THEORY COURSES												
1	BD24T31	Big Data Security	PCC	45	0	0	45	90	3	40	60	100
2	BD24T32	Information Storage Management	PCC	45	0	0	45	90	3	40	60	100
3	CS24T37	Artificial Intelligence Techniques	PCC	45	0	0	45	90	3	40	60	100
4		Professional Elective - V	PEC	45	0	0	45	90	3	40	60	100
5		Audit courses	AC	30	0	0	0	30	0	100	-	100
LABORATORY COURSES												
6	BD24P31	Project Phase – I	EEC	0	0	180	0	180	6	60	40	100
TOTAL				**210**	**0**	**180**	**180**	**570**	**18**	**600**		

SEMESTER IV

S. No.	Course Code	Course Title	Category	Periods / Semester					Credit	Max. Marks		
				L	T	P	SL	Tot	C = T/30	CA	ES	Tot
LABORATORY COURSES												
1	BD24P41	Project Phase – II	EEC	0	0	360	0	360	12	60	40	100
TOTAL				**0**	**0**	**360**	**0**	**360**	**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 / Semester					Credit	Max. Marks		
				L	T	P	SL	Tot	C=T/30	CA	ES	Tot
1	MA24T16	Operations Research	I	45	0	0	45	90	3	40	60	100
TOTAL				**45**	**0**	**0**	**45**	**90**	**3**	-	-	-

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PROFESSIONAL CORE COURSES (PCC)

S. No.	Course Code	Course Title	Semester	Periods / Semester					Credit	Max. Marks		
				L	T	P	SL	Tot	C=T/30	CA	ES	Tot
1	CS24T16	Advanced Data Structures and Algorithms	I	45	0	0	45	90	3	40	60	100
2	CS24T17	Database Practices	I	45	0	0	45	90	3	40	60	100
3	BD24T16	Foundations of Data Science	I	45	0	0	45	90	3	40	60	100
4	CS24P16	Advanced Data Structures and Algorithms Laboratory	I	0	0	60	0	60	2	60	40	100
5	BD24P11	Foundations of Data Science Laboratory	I	0	0	60	0	60	2	60	40	100
6	BD24T26	Big Data Mining and Analytics	II	45	0	0	45	90	3	40	60	100
7	CS24T27	Cloud Computing	II	45	0	0	45	90	3	40	60	100
8	BD24T27	Machine Learning Techniques	II	45	0	0	45	90	3	40	60	100
9	BD24P26	Big Data Mining and Analytics Laboratory	II	0	0	60	0	60	2	60	40	100
10	CS24P26	Cloud Computing Laboratory	II	0	0	60	0	60	2	60	40	100
11	BD24T31	Big Data Security	III	45	0	0	45	90	3	40	60	100
12	BD24T32	Information Storage Management	III	45	0	0	45	90	3	40	60	100
13	CS24T37	Artificial Intelligence Techniques	III	45	0	0	45	90	3	40	60	100
TOTAL				405	0	240	405	1050	35	-	-	-

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S. No.	Course Code	Course Title	Semester	Periods / Semester					Credit	Max. Marks		
				L	T	P	SL	Tot	C=T/30	CA	ES	Tot
1	BD24P21	Technical Presentation	II	0	0	60	0	60	2	60	40	100
2	BD24P31	Project Phase – I	III	0	0	180	0	180	6	60	40	100
3	BD24P41	Project Phase – II	IV	0	0	360	0	360	12	60	40	100
TOTAL				0	0	600	0	600	20	-	-	-

RESEARCH METHODOLOGY COURSES(REC)

S. No.	Course Code	Course Title	Semester	Periods / Semester					Credit	Max. Marks		
				L	T	P	SL	Tot	C=T/30	CA	ES	Tot

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1	RM24T09	Research Methodology and IPR	II	45	0	0	45	90	3	40	60	100
TOTAL				45	0	0	45	90	3	-	-	-

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

S. No.	Course Code	Course Title	Semester	Periods / Semester					Credit	Max. Marks		
				L	T	P	SL	Tot	C=T/30	CA	ES	Tot
1	BD24E01	Embedded Systems and IIOT	I	45	0	0	45	90	3	40	60	100
2	BD24E02	Statistics for Business Analytics	I	45	0	0	45	90	3	40	60	100
3	CS24E04	Object Oriented Software Engineering	I	45	0	0	45	90	3	40	60	100
4	BD24E03	Data Visualization Techniques	I	45	0	0	45	90	3	40	60	100
5	BD24E04	Agile Methodologies	I	45	0	0	45	90	3	40	60	100
6	CS24E06	Multicore Architectures	I	45	0	0	45	90	3	40	60	100
7	BD24E05	Web Services and API Design	I	45	0	0	45	90	3	40	60	100
8	BD24E06	High Performance Computing for Big Data	I	45	0	0	45	90	3	40	60	100
9	CS24T18	Network technologies	I	45	0	0	45	90	3	40	60	100
10	BD24E07	Data Intensive Computing	I	45	0	0	45	90	3	40	60	100

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

S. No.	Course Code	Course Title	Semester	Periods / Semester					Credit	Max. Marks		
				L	T	P	SL	Tot	C=T/30	CA	ES	Tot
1	BD24E08	Internet of Things	II	45	0	0	45	90	3	40	60	100
2	CS24E09	Full Stack Web Application Development	II	45	0	0	45	90	3	40	60	100
3	CS24E10	Deep learning	II	45	0	0	45	90	3	40	60	100
4	BD24E09	Blockchain Technologies	II	45	0	0	45	90	3	40	60	100
5	CS24E11	Natural Language Processing	II	45	0	0	45	90	3	40	60	100
6	BD24E10	Cyber Physical Systems	II	45	0	0	45	90	3	40	60	100
7	BD24E11	Image and Video Analytics	II	45	0	0	45	90	3	40	60	100
8	CS24E13	Quantum Computing	II	45	0	0	45	90	3	40	60	100

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9	BD24E12	Information Retrieval Techniques	II	45	0	0	45	90	3	40	60	100
10	BD24E13	Web Analytics	II	45	0	0	45	90	3	40	60	100

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

S. No.	Course Code	Course Title	Semester	Periods / Semester					Credit	Max. Marks		
				L	T	P	SL	Tot	C=T/30	CA	ES	Tot
1	BD24E14	DevOps and Microservices	III	45	0	0	45	90	3	40	60	100
2	CS24T36	Soft Computing	III	45	0	0	45	90	3	40	60	100
3	BD24E15	Healthcare Analytics	III	45	0	0	45	90	3	40	60	100
4	BD24E16	Predictive Modeling	III	45	0	0	45	90	3	40	60	100
5	BD24E17	Social Network Analysis	III	45	0	0	45	90	3	40	60	100

AUDIT COURSES (SEMESTER – III)

S. No.	Course Code	Course Title	Semester	Periods / Semester					Credit	Max. Marks		
				L	T	P	SL	Tot	C=T/30	CA	ES	Tot
1	AX24A01	Disaster Management	III	30	0	0	0	30	0	100	-	100
2	AX24A02	Value Education	III	30	0	0	0	30	0	100	-	100
3	AX24A03	Constitution of India	III	30	0	0	0	30	0	100	-	100
4	AX24A04	Indian Knowledge System	III	30	0	0	0	30	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	9	-	35	46.05
REC	-	3	-	-	3	3.94
PEC	6	6	3	-	15	19.73
EEC	-	2	6	12	20	26.31
AC	-	-	✓	-	-	-
Total	22	24	18	12	76	100

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MA24T16	OPERATIONS RESEARCH	Category	L	T	P	SL	C
		FC	45	0	0	45	3

SEMESTER - I (M.E. : Common to CSE, 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 :
To determine the most effective way to allocate the best value of linear programming, minimize the total transportation cost and to find the optimal way to assign a set of tasks, the optimal quantity of inventory to hold the balancing between excess and shortage , analyze the basic components and behavior of queuing systems , shortest path in PERT/CPM , Network design.

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): $(\infty/FIFO)$ Single Server with infinite capacity – (M/M/C) : $(\infty/FIFO)$ 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.

Lecture = 45, Tutorial = 0 , Self Learning = 45 ; Total = 90 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 to solve the uncertain situations.	Apply
CO2	Analyze the transportation models and solve Assignment problems to minimize the costs.	Analyze
CO3	Apply the inventory models using EOQ and EBQ with and without shortage.	Apply
CO4	Analyze and interpret the key features of various queuing systems	Analyze
CO5	Perform optimistic and pessimistic analysis using PERT/CPM networks.	Apply

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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	PO4	PO5
CO1	3	-	2	-	2
CO2	3	-	2	-	2
CO3	3	-	2	-	2
CO4	3	-	2	-	2
CO5	3	-	2	-	2

1 - Low, 2 - Medium, 3- High .

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CS24T16	ADVANCED DATA STRUCTURES AND ALGORITHMS	Category	L	T	P	SL	C
		PCC	45	0	0	45	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:

To equip students with the knowledge and skills to analyze algorithm efficiency, implement advanced data structures, apply graph algorithms, utilize dynamic programming and greedy techniques, and understand computational complexity including NP-completeness and approximation methods.

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.

L:45, T:0, P:0, SL:45, TOTAL: 90 PERIODS

COURSE OUTCOMES:

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

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COs	Course Outcome	Cognitive Level
CO1	Summarize the fundamental concepts of algorithm efficiency and apply complexity analysis methods.	Understand
CO2	Describe 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	Demonstrate 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, 4th 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	PO4	PO5
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

1-low, 2-medium, 3-high

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CS24T17	DATABASE PRACTICES	Category	L	T	P	SL	C
		PCC	45	0	0	45	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:

To provide students with a comprehensive understanding of relational and advanced database concepts, including SQL, database design, distributed and active databases, XML data management and emerging technologies such as NoSQL and big data storage systems.

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 – Dynamo DB Overview – Voldemort Key-Value Distributed Data Store – Column-Based or Wide Column NoSQL Systems – NoSQL Graph Databases and Neo4j – Big Data – MapReduce – Hadoop – YARN.

L:45, T:0, P:0, SL:45, TOTAL: 90 PERIODS

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

COs	Course Outcome	Cognitive Level
CO1	Describe the key concepts of the relational model, relational algebra operations, and SQL commands used in relational database systems.	Understand
CO2	Develop relational database designs by applying E-R modeling and normalization principles to meet specific data storage requirements.	Apply
CO3	Summarize the concepts and architecture of distributed databases, active databases, and Open Database Connectivity to support effective data management.	Understand
CO4	Apply XML technologies to manage structured, semi-structured, and unstructured data, and integrate XML documents with relational databases.	Apply
CO5	Implement NoSQL database models and big data frameworks like Hadoop and MapReduce for scalable and efficient data storage solutions.	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	PO4	PO5
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

1-low, 2-medium, 3-high

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BD24T16	FOUNDATIONS OF DATA SCIENCE	Category	L	T	P	SL	C
		PEC	45	0	0	45	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:

To equip students with foundational knowledge and practical skills in data science by covering data analysis, statistical methods, data wrangling using Python libraries, and effective data visualization techniques for insightful decision-making.

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.

L:45, T:0, P:0, SL:45, TOTAL: 90 PERIODS

COURSE OUTCOMES:

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

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COs	Course Outcome	Cognitive Level
CO1	Enlighten the fundamental concepts, benefits, processes and applications of data science.	Understand
CO2	Summarize and interpret different types of data using statistical measures, tables and graphical methods.	Understand
CO3	Apply correlation and regression techniques to analyze and interpret relationships between variables in data.	Apply
CO4	Use Python libraries such as NumPy and Pandas to manipulate, clean, and organize datasets for analysis.	Apply
CO5	Analyze data using visualizations with Matplotlib and Seaborn to interpret patterns effectively.	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	PO4	PO5
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

1-low, 2-medium, 3-high

Chairman (BoS)

CS24P16	ADVANCED DATA STRUCTURES AND ALGORITHMS LABORATORY	Category	L	T	P	SL	C
		PCC	0	0	60	0	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:

To equip students with the skills to design, implement, and analyze recursive functions, sorting algorithms, tree and graph data structures, and optimization techniques for solving a wide range of computational and real-world problems.

List of 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.

L:0, T:0, P:60, SL:0, TOTAL: 60 PERIODS

Chairman (BoS)

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

COs	Course Outcome	Experiments	Cognitive Level
CO1	Develop recursive solutions for tree traversals and implement efficient sorting algorithms like Merge Sort and Quick Sort.	1,2	Apply
CO2	Construct and manipulate BSTs, Red-Black Trees, and Heaps for efficient data storage and retrieval.	3,4,5	Apply
CO3	Implement Fibonacci Heaps and apply Prim's and Kruskal's algorithms for minimum spanning tree construction.	6,7,8	Apply
CO4	Design and apply Dijkstra's and Bellman-Ford algorithms for single-source shortest path problems.	9,10	Apply
CO5	Apply dynamic programming and greedy algorithms to solve optimization problems.	11,12	Apply

LIST OF EQUIPMENTS

Sl.No	Name of the Equipment's	Qty.
1.	A computer with a modern processor, RAM and Windows or Linux.	10 Nos.
2.	Turbo C software or any standard C/C++ compiler (e.g., GCC, Code Blocks)	10 Nos.
3.	Text editor/IDE such as Notepad or Turbo C IDE	10 Nos.

REFERENCES:

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

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5
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

1-low, 2-medium, 3-high

Chairman (BoS)

BD24P11	FOUNDATIONS OF DATA SCIENCE LABORATORY	Category	L	T	P	SL	C
		PCC	0	0	60	0	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:

To explore Python data science libraries for data manipulation, analysis, and visualization using datasets and geographic data.

List of 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

L:0, T:0, P:60, SL:0, TOTAL: 60 PERIODS

Chairman (BoS)

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

COs	Course Outcome	Experiments	Cognitive Level
CO1	Demonstrate proficiency in installing and exploring features of NumPy, SciPy, Jupyter, Stats models, and Pandas.	1,2	Apply
CO2	Effectively work with NumPy arrays and Pandas data frames for data processing and analysis.	3,4	Apply
CO3	Perform univariate, bivariate, and multiple regression analyses on provided datasets, and compare results.	5,6	Apply
CO4	Generate and interpret various plots, such as normal curves, density plots, and 3D plots, to visualize data trends and patterns.	7,8	Apply
CO5	Utilize Basemap to visualize and analyze geographic data, enhancing spatial data interpretation.	9,10	Apply

LIST OF EQUIPMENTS

Sl.No	Name of the Equipment's	Qty.
1.	Computer system with modern processor, RAM and Windows or Linux.	10 Nos.
2.	Python libraries (NumPy, SciPy, Pandas, Statsmodels, Matplotlib, Seaborn, Basemap).	10 Nos.
3.	IDE or text editor (VS Code, MySQL Workbench, Jupyter Notebook) with Java/Python support.	10 Nos.

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	PO4	PO5
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

1-low, 2-medium, 3-high

Chairman (BoS)

RM24T09	RESEARCH METHODOLOGY AND IPR	Category	L	T	P	SL	C
		RMC	45	0	0	45	3

(Common to ALL)

PREREQUISITE:

Basic understanding of research methodology and general awareness of legal and innovation-related frameworks.

OBJECTIVE:

- To equip learners with the knowledge and skills to design and conduct research, analyze data effectively, and understand the fundamentals of intellectual property rights and patent processes.

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.

LECTURE: 45, SELF LEARNING: 45, TOTAL: 90 PERIODS

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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.	Understand
CO5	Illustrate the patent procedures, E-filling, register of patents, and licensing of patents.	Understand

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	PO 1	PO 2	PO 3	PO 4	PO 5
CO1	3	3	-	-	3
CO2	3	3	-	-	3
CO3	3	3	-	-	3
CO4	3	3	-	-	3
CO5	3	3	-	-	3

1 - Low, 2 - Medium, 3 - High

Chairman (BoS)

K.S.R College of Engineering, Tiruchengode-637215, Centre for Academic Courses

BD24T26	BIG DATA MINING AND ANALYTICS	Category	L	T	P	SL	C
		PCC	45	0	0	45	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

To provide students with comprehensive knowledge of big data analytics by exploring statistical modeling, machine learning, data stream processing, clustering techniques and Hadoop ecosystem tools for managing and integrating structured and unstructured data at scale.

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.

L:45, T:0, P:0, SL:45, TOTAL: 90 PERIODS

COURSE OUTCOMES:

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

COs	Course Outcome	Cognitive Level

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CO1	Outline statistical modeling, machine learning and MapReduce for large-scale data processing.	Understand
CO2	Summarize key concepts of stream data processing, such as distinct counting, moment estimation, and decaying window techniques.	Understand
CO3	Compare various clustering methods and develop effective models using partitioning, hierarchical, and density-based techniques.	Apply
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	PO4	PO5
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

1-low, 2-medium, 3-high

Chairman (BoS)

CS24T27	CLOUD COMPUTING	Category	L	T	P	SL	C
		PCC	45	0	0	45	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:

To provide students with a thorough understanding of cloud computing concepts, deployment models, architectural designs, security and privacy issues, regulatory considerations, and the use of major industrial cloud platforms for real-world applications.

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

L:45, T:0, P:0, SL:45, TOTAL: 90 PERIODS

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

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COs	Course Outcome	Cognitive Level
CO1	Identify core concepts, service models, and architectural challenges in cloud computing.	Understand
CO2	Summarize deployment models and address infrastructure and data security issues.	Understand
CO3	Infer the privacy, compliance, and legal concerns in global cloud environments.	Understand
CO4	Utilize cloud platforms like AWS, Azure, and Google Cloud for practical applications.	Apply
CO5	Implement basic cloud security practices across SaaS, PaaS, and IaaS layers	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	PO4	PO5
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

1-low, 2-medium, 3-high

Chairman (BoS)

BD24T27	MACHINE LEARNING TECHNIQUES	Category	L	T	P	SL	C
		PEC	45	0	0	45	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:

To provide a strong foundation in machine learning by covering core mathematical principles, supervised and unsupervised learning techniques, graphical models, 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.

L:45, T:0, P:0, SL:45, TOTAL: 90 PERIODS

COURSE OUTCOMES:

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

COs	Course Outcome	Cognitive Level

Chairman (BoS)

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 complex data using probabilistic graphical models like Bayesian networks and Markov Random Fields.	**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	PO4	PO5
CO1	3	1	3	2	1
CO2	3	1	3	2	1
CO3	3	1	3	2	1
CO4	3	1	2	2	1
CO5	3	1	3	2	1

1-low, 2-medium, 3-high

Chairman (BoS)
K.S.R College of Engineering

BD24P26	BIG DATA MINING AND ANALYTICS LABORATORY	Category	L	T	P	SL	C
		PCC	0	0	60	0	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:

To equip students with hands-on skills in setting up big data platforms like Hadoop and Spark, developing MapReduce applications, applying machine learning and clustering techniques using R, visualizing data, and integrating NoSQL databases such as HBase or MongoDB for scalable big data processing.

List of 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

L:0, T:0, P:60, SL:0, TOTAL: 60 PERIODS

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

COs	Course Outcome	Experiments	Cognitive Level
CO1	Demonstrate the ability to install, configure, and effectively manage Hadoop and HDFS for big data environments.	1	Apply
CO2	Develop and execute MapReduce programs for efficient data processing.	2,3	Apply

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CO3	Apply SVM and clustering techniques in R and visualize data effectively.	**4,5**	Apply
CO4	Implement and manage storage solutions for large datasets using HBase or MongoDB, integrating them with Hadoop or R.	**6**	Apply
CO5	Deploy and use Apache Spark for distributed data processing applications.	**7**	Apply

LIST OF EQUIPMENTS

Sl.No	Name of the Equipment's	Qty.
1.	High-performance computer systems, RAM, Linux OS or virtual environment, and Java installed.	10 Nos.
2.	Big Data tools and platforms including Hadoop, HDFS, MapReduce, Apache Spark, R with relevant packages and NoSQL databases like MongoDB or HBase.	10 Nos.
3.	Development and visualization tools such as VS Code, RStudio, Python with plotting libraries, and internet access for setup and resources.	10 Nos.

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	PO4	PO5
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

1-low, 2-medium, 3-high

Chairman (BoS)

CS24P26	CLOUD COMPUTING LABORATORY	Category	L	T	P	SL	C
		PCC	0	0	60	0	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:

To provide students with practical knowledge in virtualization, network configuration, protocol implementation, and cloud resource management by working with hypervisors, virtual machines, network virtualization tools, and simulation environments.

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).

L:0, T:0, P:60, SL:0, TOTAL: 60 PERIODS

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

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COs	Course Outcome	Cognitive Level
CO1	Set up virtual machines and enable communication, and create simple network topologies using virtualization tools.	Apply
CO2	Implement network protocols using controllers and analyze scheduling mechanisms with cloud simulation tools.	Apply
CO3	Utilize open-source cloud platforms to explore scheduling, load balancing, and security mechanisms like hashing and encryption.	Apply
CO4	Explore and use collaborative applications offered as Software as a Service (SaaS) in cloud environments.	Apply
CO5	Develop cloud applications using Google App Engine and implement MapReduce programs on single and multi-node Hadoop clusters.	Apply

LIST OF EQUIPMENTS

Sl.No	Name of the Equipment's	Qty.
1.	Computer systems with minimum RAM, running Linux or virtualized environments.	10 Nos.
2.	Tools: VirtualBox, VMware, OpenStack, OpenDaylight, Mininet, CloudSim, Hadoop, Google App Engine.	10 Nos.
3.	Internet access for cloud services, software installation, and collaborative SaaS tools.	10 Nos.

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	PO4	PO5
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

1-low, 2-medium, 3-high

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BD24P21	TECHNICAL PRESENTATION	Category	L	T	P	SL	C
		EEC	0	0	60	0	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:

To enable students to explore and understand recent advancements in their field of study by selecting a current technical topic, engaging in faculty-guided research and effectively presenting their findings with originality and clarity.

Guidelines:

1. Students should refer to recently published journals and conference proceedings to select a relevant and up-to-date topic.
2. A technical topic must be chosen in consultation with the faculty, based on the student's area of interest.
3. Students must present their findings and understanding through a final technical presentation.

L:0, T:0, P:60, SL:0, TOTAL: 60 PERIODS

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

COs	Course Outcome	Cognitive Level
CO1	Outline a deep understanding of the topic and its relevance to current research trends.	Understand
CO2	Communicate technical content effectively with clarity and confidence.	Understand
CO3	Conduct independent research and compile findings into a structured, coherent report.	Understand
CO4	Infer existing research and identify potential areas for future exploration.	Understand
CO5	Incorporate feedback to enhance research quality and presentation skills.	Understand

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Mapping of COs with POs and PSOs					
COs/ POs	PO1	PO2	PO3	PO4	PO5
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
1-low, 2-medium, 3-high					

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BD24T31	BIG DATA SECURITY	Category	L	T	P	SL	C
		PCC	45	0	0	45	3

PREREQUISITE

Basic knowledge about networking, programming and scripting with cryptographic techniques is needed for better understanding and deployment.

OBJECTIVES:

This course introduces cryptographic techniques and authentication methods, along with security analytics for threat detection. It enables students to apply these concepts to protect data and analyze security events effectively.

UNIT – I	SYMMETRIC TECHNIQUES	(9)

Probability and Information Theory – Algebraic foundations – Number theory – Substitution Ciphers – Transposition Ciphers – Classical Ciphers – DES – AES – Confidentiality Modes of Operation

UNIT – II	ASYMMETRIC TECHNIQUES	(9)

Diffie-Hellman Key Exchange protocol – Discrete logarithm problem – RSA cryptosystems and cryptanalysis – ElGamal cryptosystem – Elliptic curve architecture and cryptography – Data Integrity techniques.

UNIT – III	AUTHENTICATION	(9)

Authentication requirements – Authentication functions – Message authentication codes – Hash functions – Security of hash functions and MACS – MD5 Message Digest algorithm – Secure hash algorithm.

UNIT – IV	SECURITY ANALYTICS I	(9)

Introduction to Security Analytics – Techniques in Analytics – Analysis in everyday life – Challenges in Intrusion and Incident Identification – Analysis of Log file – Simulation and Security Process.

UNIT – V	SECURITY ANALYTICS II	(9)

Access Analytics – Security Analysis with Text Mining – Security Intelligence – Security Breaches

L:45, T:0, P:0, SL:45, TOTAL: 90 PERIODS

COURSE OUTCOMES:

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

COs	Course Outcome	Cognitive Level
CO1	Describe the fundamentals of symmetric encryption and assess classical and modern algorithms such as DES and AES.	Understand
CO2	Implement asymmetric encryption techniques like RSA, ElGamal, and ECC to establish secure communication.	Apply
CO3	Demonstrate the use of authentication techniques and hashing algorithms to ensure message integrity and security.	Apply
CO4	Examine and interpret security events using log file analysis and intrusion detection techniques in security analytics.	Analyze

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CO5	Employ advanced analytics techniques like access analysis and text mining to detect security breaches and generate intelligence.	Apply

REFERENCES:

1. William Stallings, Cryptography and Network security: Principles and Practices, Pearson/PHI, Fifth Edition, 2010.
2. Behrouz A. Forouzan, Cryptography and Network Security, Tata McGraw Hill Education, Second Edition, 2010.
3. Douglas R. Stinson, Cryptography Theory and Practice, Chapman & Hall/CRC, Third Edition, 2006.
4. Mark Talabis, Robert McPherson, I Miyamoto and Jason Martin, Information Security Analytics: Finding Security Insights, Patterns, and Anomalies in Big Data, Syngress Media, U.S., First Edition, 2014
5. Shibakali Guipta, Indiradip Banarjee, Siddhartha Bhattacharyya, Big Data Security, De Gruyter, First Edition, 2019.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5
CO1	3	2	2	3	1
CO2	3	2	2	2	1
CO3	3	2	2	3	1
CO4	3	2	2	2	1
CO5	3	2	2	3	1

1-low, 2-medium, 3-high

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BD24T32	INFORMATION STORAGE MANAGEMENT	Category	L	T	P	SL	C
		PCC	45	0	0	45	3

PREREQUISITE

Students are expected to have basic knowledge of computer architecture, operating systems and networking concepts. Familiarity with storage devices and file systems is also helpful.

OBJECTIVES:

To introduce the architecture, technologies, and best practices in information storage systems including SAN, NAS, RAID, virtualization, and cloud environments, with a focus on performance, security and data lifecycle management.

UNIT – I	INTRODUCTION TO INFORMATION STORAGE	(9)

Information Storage – Evolution of Storage Architecture – Data Center Infrastructure – Virtualization and Cloud Computing – Overview of storage infrastructure components – Information Lifecycle Management – Data Categorization Application – Disk drive and flash drive components and performance.

UNIT – II	STORAGE NETWORKING TECHNOLOGIES	(9)

Components of a Storage System Environment – Disk Drive Components – Disk Drive Performance – Fiber Channel SAN components – FC protocol and operations – Block level storage virtualization – iSCL and FCIP as an IP-SAN solution – Disk physical structure components, properties, performance and specifications.

UNIT – III	INTELLIGENT STORAGE SYSTEM AND REPLICATION	(9)

Implementation of RAID – RAID Array Components – RAID Levels – RAID Comparison –RAID Impact on Disk Performance – Components of an Intelligent Storage System – Intelligent Storage Array – Remote replication in classic and virtual environments – Three-site remote replication and continuous data protection.

UNIT – IV	NETWORK ATTACHED STORAGE	(9)

General Purpose Servers vs NAS Devices –Benefits of NAS – NAS File I/O – Components of NAS – NAS Implementations – NAS File – Sharing Protocols: NAS I/O Operations – Factors Affecting NAS Performance and Availability – Concepts in Practice: Isilon and VNX Gateway.

UNIT – V	SECURING AND MANAGING	(9)

Storage Infrastructure Security threats – Countermeasures in various domains – Security Solutions for FC – SAN – IP-SAN and NAS environments – Security in virtualized and cloud environments – Monitoring and managing various information infrastructure components – Information lifecycle Management and storage tiering.

L:45, T:0, P:0, SL:45, TOTAL: 90 PERIODS

COURSE OUTCOMES:

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

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COs	Course Outcome	Cognitive Level
CO1	Outline the evolution of storage architectures and identify key components of modern storage infrastructure including virtualization and cloud-based systems.	Understand
CO2	Illustrate the structure and performance characteristics of storage networking technologies such as SAN, FC, iSCSI, and IP-SAN.	Understand
CO3	Implement RAID techniques and evaluate intelligent storage system architectures and replication strategies.	Apply
CO4	Compare NAS architectures and protocols, and assess their performance and availability in various use cases.	Analyze
CO5	Apply security mechanisms and management practices for securing and monitoring storage infrastructure in physical, virtual, and cloud environments.	Apply

REFERENCES:

6. G.Somasundaram, A.Shrivastava, Information Storage and Management: Storing, Managing and Protecting Digital Information in Classic, Virtualized and Cloud Environment, Second Edition, Wiley publication, 2016.
7. Nigel Poulton, Data Storage Networking||, First Edition, Wiley publication, 2014.
8. Somasundaram Gnanasundaram and Alok Shrivastava Information Storage and Management: Storing, Managing and Protecting Digital Information in classic, Virtualized and Cloud Environments, Second Edition, EMC Educations Services, Wiley, 2012.
9. Tom Clark, Storage Virtualization: Technologies for Simplifying Data Storage and Management, First Edition, Pearson Education, 2018.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PSO1	PSO2
CO1	2	2	1	2	2
CO2	2	2	1	2	2
CO3	2	2	1	2	2
CO4	2	2	1	2	2
CO5	2	2	1	2	2

1-low, 2-medium, 3-high

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CS24T37	ARTIFICIAL INTELLIGENCE TECHNIQUES	Category	L	T	P	SL	C
		PCC	45	0	0	45	3

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

PREREQUISITE

The AI course requires basic knowledge of data structures, algorithms, and probability. Understanding logic and reasoning is essential. Programming skills, preferably in Python, are also needed.

OBJECTIVES:

To equip students with the foundational concepts, problem-solving techniques, reasoning methods, and ethical considerations essential for designing intelligent systems.

UNIT – I	INTRODUCTION AND PROBLEM SOLVING	(9)

Artificial Intelligence – Introduction – Problem-solving – Solving Problems by Searching – Uninformed Search Strategies – Informed (Heuristic) Search Strategies – Local Search – Search in Partially Observable Environments

UNIT – II	ADVERSARIAL SEARCH AND CONSTRAINT SATISFACTION PROBLEMS	(9)

Game Theory – Optimal Decisions in Games – Heuristic Alpha – Beta Tree Search – Monte Carlo Tree Search – Stochastic Games – Partially Observable Games – Limitations of Game Search Algorithms Constraint Satisfaction Problems (CSP) – Examples – Constraint Propagation – Backtracking Search for CSPs – Local Search for CSPs

UNIT – III	KNOWLEDGE, REASONING AND PLANNING	(9)

First Order Logic – Inference in First Order Logic – Using Predicate Logic – Knowledge Representation – Issues – Ontological Engineering – Categories and Objects – Reasoning Systems for Categories – Planning – Definition – Algorithms – Heuristics for Planning – Hierarchical Planning

UNIT – IV	UNCERTAIN KNOWLEDGE AND REASONING	(9)

Quantifying Uncertainty – Probabilistic Reasoning – Probabilistic Reasoning over Time Probabilistic Programming – Making Simple Decisions – Making Complex Decisions – Case Based Reasoning – Explanation-Based Learning – Evolutionary Computation

UNIT – V	PHILOSOPHY, ETHICS AND SAFETY OF AI	

The Limits of AI – Knowledge in Learning – Statistical Learning Methods – Reinforcement Learning – Introduction to Machine Learning and Deep Learning – Can Machines Really Think? – Distributed AI Artificial Life –The Ethics of AI – Interpretable AI- Future of AI – AI Components – AI Architectures.

L:45, T:0, P:0, SL:45, TOTAL: 90 PERIODS

COURSE OUTCOMES:

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

COs	Course Outcome	Cognitive Level

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CO1	Identify the core principles of AI and use search methods to solve problems.	Understand
CO2	Apply adversarial search and constraint satisfaction methods to solve AI problems.	Apply
CO3	Use logic-based techniques for knowledge representation, reasoning, and planning.	Apply
CO4	Implement probabilistic methods to support decisions in uncertain environments.	Apply
CO5	Discuss AI ethics, safety, and emerging trends like machine learning and interpretable AI.	Understand

REFERENCES:

1. Stuart Russell, Peter Norvig, "Artificial Intelligence: A Modern Approach", Pearson, 4th Edition, 2020.
2. Zhongzhi Shi "Advanced Artificial Intelligence", World Scientific; 2019.
3. Kevin Knight, Elaine Rich, Shivashankar B. Nair, "Artificial Intelligence", McGraw Hill Education; 3rd edition, 2017
4. Richard E. Neapolitan, Xia Jiang, "Artificial Intelligence with an Introduction to Machine Learning", Chapman and Hall/CRC; 2nd edition, 2018 50 51
5. Dheepak Khemani, "A first course in Artificial Intelligence", McGraw Hill Education Pvt Ltd., New Delhi, 2013.
1. 6. Nils J. Nilsson, "Artificial Intelligence: A New Synthesis", Morgan Kaufmann Publishers Inc; Second Edition, 2003.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5
CO1	2	1	2	2	3
CO2	2	1	2	2	3
CO3	2	1	3	2	3
CO4	2	1	2	2	3
CO5	2	1	2	1	3

1-low, 2-medium, 3-high

Chairman (BoS)

BD24P31	PROJECT PHASE – I	Category	L	T	P	SL	C
		PCC	0	0	180	0	6

PREREQUISITE

Students should have a strong foundation in core computer science subjects such as programming, databases, algorithms and system design. Prior exposure to research methodologies, technical writing and project-based learning is essential.

OBJECTIVES:

The project work aims to enhance students' ability to apply theoretical knowledge to real-world problems through research, design, and development. It encourages innovation, critical thinking and technical proficiency in solving domain-specific challenges. The objective also includes strengthening independent learning, teamwork and professional communication skills.

GUIDELINES:

1. Each student can undertake the project individually or group.
2. The project must be related to the student's area of specialization.
3. The project can focus on software, hardware, applications, research, innovation, industry, or societal impact.
4. Students must refer to reputed journals and articles.
5. Each project will be guided by a faculty member from the same specialization.
6. Students should carry out a detailed literature survey.
7. Contact hours will be provided in the timetable for guidance, library work, lab work, and computer-based analysis.
8. The goal is to apply theoretical knowledge to solve new or practical problems.
9. Students must design, implement, and evaluate systems using appropriate methods.
10. Project progress will be monitored through at least three formal review sessions.
11. Students are encouraged to publish a paper related to their project work in reputed journals or conferences.
12. Students must prepare and submit the final project report as per academic rules.

L:0, T:0, P:60, SL:0, TOTAL: 60 PERIODS

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

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COs	Course Outcome	Cognitive Level
CO1	Apply the principles of computer science and engineering to design solutions for real-world problems.	Apply
CO2	Analyze research literature to identify relevant methods, models and tools for solving the defined problem	Analyze
CO3	Design and develop a system or model using appropriate techniques, tools, and technologies.	Apply
CO4	Evaluate the performance and effectiveness of the developed solution through testing and validation.	Evaluate
CO5	Create technical reports and research articles and present findings effectively for academic or industrial dissemination.	Create

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5
CO1	3	1	3	3	3
CO2	3	1	3	2	3
CO3	3	1	3	3	3
CO4	3	1	3	2	3
CO5	3	3	3	2	2

1-low, 2-medium, 3-high

Chairman (BoS)

BD24P41	PROJECT PHASE – II	Category	L	T	P	SL	C
		PCC	0	0	360	0	12

PREREQUISITE

Students should have a strong foundation in core computer science subjects such as programming, databases, algorithms and system design. Prior exposure to research methodologies, technical writing and project-based learning is essential.

OBJECTIVES:

The project work aims to enhance students' ability to apply theoretical knowledge to real-world problems through research, design, and development. It encourages innovation, critical thinking and technical proficiency in solving domain-specific challenges. The objective also includes strengthening independent learning, teamwork and professional communication skills.

GUIDELINES:

1. Each student can undertake the project individually or group.
2. The project must be related to the student's area of specialization.
3. The project can focus on software, hardware, applications, research, innovation, industry, or societal impact.
4. Students must refer to reputed journals and articles.
5. Each project will be guided by a faculty member from the same specialization.
6. Students should carry out a detailed literature survey.
7. Contact hours will be provided in the timetable for guidance, library work, lab work, and computer-based analysis.
8. The goal is to apply theoretical knowledge to solve new or practical problems.
9. Students must design, implement, and evaluate systems using appropriate methods.
10. Project progress will be monitored through at least three formal review sessions.
11. Students are encouraged to publish a paper related to their project work in reputed journals or conferences.
12. Students must prepare and submit the final project report as per academic rules.

L:0, T:0, P:60, SL:0, TOTAL: 60 PERIODS

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

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COs	Course Outcome	Cognitive Level
CO1	Apply the principles of computer science and engineering to design solutions for real-world problems.	Apply
CO2	Analyze research literature to identify relevant methods, models and tools for solving the defined problem	Analyze
CO3	Design and develop a system or model using appropriate techniques, tools, and technologies.	Apply
CO4	Evaluate the performance and effectiveness of the developed solution through testing and validation.	Evaluate
CO5	Create technical reports and research articles and present findings effectively for academic or industrial dissemination.	Create

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5
CO1	3	1	3	3	3
CO2	3	1	3	2	3
CO3	3	1	3	3	3
CO4	3	1	3	2	3
CO5	3	3	3	2	2

1-low, 2-medium, 3-high

Chairman (BoS)

BD24E01	EMBEDDED SYSTEMS AND IIOT (PROFESSIONAL ELECTIVES – I and II)	Category	L	T	P	SL	C
		PEC	45	0	0	45	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:

To gain a comprehensive understanding of 8051 microcontroller architecture and embedded systems development using C programming, while exploring the architecture, components, communication technologies, and the roles of cloud and edge computing in the Industrial Internet of Things (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.

L:45, T:0, P:0, SL:45, TOTAL: 90 PERIODS

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

COs	Course Outcome	Cognitive Level
CO1	Identify the architecture and functioning of 8051 microcontrollers and their interfacing techniques.	Understand
CO2	Develop embedded C programs for implementing timers, interrupts, and multitasking concepts.	Apply
CO3	Identify and describe the components and architecture of IIoT systems.	Understand
CO4	Differentiate and evaluate various communication protocols used in IIoT applications.	Analyze
CO5	Apply cloud and edge computing concepts to connect IIoT devices to online platforms.	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, "IoT 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

1-low, 2-medium, 3-high

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BD24E02	STATISTICS FOR BUSINESS ANALYTICS (PROFESSIONAL ELECTIVES – I and II)	Category	L	T	P	SL	C
		PEC	45	0	0	45	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:

To develop a comprehensive understanding of statistical analysis techniques, including time series analysis, estimation methods, statistical inference, regression, system reliability evaluation, and statistical quality control, with emphasis on both theoretical foundations and practical applications.

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 $\phi(\theta)$ (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.

L:45, T:0, P:0, SL:45, TOTAL: 90 PERIODS

Chairman (BoS)

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

1-low, 2-medium, 3-high

Chairman (BoS)

CS24E04	OBJECT ORIENTED SOFTWARE ENGINEERING (PROFESSIONAL ELECTIVES – I and II)	Category	L	T	P	SL	C
		PEC	45	0	0	45	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:

To equip students with fundamental software engineering concepts, including Agile methodologies, requirements engineering, software design principles, testing techniques, and project management practices such as DevOps.

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.

L:45, T:0, P:0, SL:45, TOTAL: 90 PERIODS

COURSE OUTCOMES:

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

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COs	Course Outcome	Cognitive Level
CO1	Summarize software engineering principles, software process models, and apply Agile methodologies such as Extreme Programming.	Understand
CO2	Apply requirement analysis techniques and create formal system models using UML, FSMs, Petri Nets, and data flow diagrams.	Apply
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	PO4	PO5
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

1-low, 2-medium, 3-high

Chairman (BoS)

BD24E03	DATA VISUALIZATION TECHNIQUES (PROFESSIONAL ELECTIVES – I and II)	Category	L	T	P	SL	C
		PEC	45	0	0	45	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:

To develop a strong foundation in data visualization by learning core design principles, exploring techniques for visualizing various data types including time-series, hierarchical, and textual data, creating interactive visualizations using tools like D3.js and Tableau, and understanding essential 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.

L:45, T:0, P:0, SL:45, TOTAL: 90 PERIODS

COURSE OUTCOMES:

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

COs	Course Outcome	Cognitive Level
CO1	Comprehend the fundamentals of data visualization, including design principles, stages, tools, and types of data representations.	Understand
CO2	Apply various techniques to visualize time-series data, hierarchies, and network graphs using appropriate chart types and layouts.	Apply
CO3	Develop visualizations for textual data using parsing tools, regular expressions, and data formats for effective representation.	Apply
CO4	Utilize techniques to create interactive visualizations using D3.js and Tableau, incorporating layouts, transitions, and user interactions.	Apply
CO5	Implement security strategies in data visualization systems, including threat detection and secure visualization design.	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

Chairman (BoS)

BD24E04	AGILE METHODOLOGIES (PROFESSIONAL ELECTIVES – I and II)	Category	L	T	P	SL	C
		PEC	45	0	0	45	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:

To provide students with a comprehensive understanding of agile principles, methodologies, and practices, focusing on agile project management, processes, requirements engineering, knowledge management, and quality assurance in software 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.

L:45, T:0, P:0, SL:45, TOTAL: 90 PERIODS

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

COs	Course Outcome	Cognitive Level
CO1	Describe the fundamental concepts of Agile software development, including values, principles and differences from traditional models	Understand
CO2	Summarize Agile methodologies such as Scrum, XP, Crystal, and FDD, focusing on their lifecycles, roles and practices	Understand
CO3	Illustrate the role of knowledge management in agile environments, including knowledge sharing practices and the use of story cards.	Understand
CO4	Handle Agile requirements engineering, including elicitation, modeling, prioritization and managing changing requirements.	Apply
CO5	Apply Agile quality assurance techniques like test-driven development, Agile metrics and practices for distributed development.	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	PO4	PO5
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

1-low, 2-medium, 3-high

Chairman (BoS)

CS24E06	MULTI CORE ARCHITECTURES (PROFESSIONAL ELECTIVES – I and II)	Category	L	T	P	SL	C
		PEC	45	0	0	45	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:

To provide a strong foundation in advanced computer architecture concepts, including performance evaluation, memory hierarchy, parallel architectures, multicore systems, and modern computing paradigms such as SIMD and GPU architectures.

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.

L:45, T:0, P:0, SL:45, TOTAL: 90 PERIODS

Chairman (BoS)

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	PO4	PO5
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

1-low, 2-medium, 3-high

Chairman (BoS)

BD24E05	WEB SERVICES AND API DESIGN (PROFESSIONAL ELECTIVES – I and II)	Category	L	T	P	SL	C
		PEC	45	0	0	45	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:

To provide a comprehensive understanding of web services and Service-Oriented Architecture (SOA), covering SOAP and RESTful principles, core technologies like WSDL and UDDI, and hands-on experience in designing and implementing resource-oriented services using frameworks such as Spring and cloud platforms.

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.

L:45, T:0, P:0, SL:45, TOTAL: 90 PERIODS

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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, including key architectural views and technologies.	Understand
CO2	Identify the components and functionality of SOAP, WSDL, and UDDI in web service development.	Understand
CO3	Apply RESTful principles to design and manage web services using HTTP methods and URIs.	Apply
CO4	Implement RESTful web services using frameworks like Spring and S3, focusing on statelessness and resource representation.	Apply
CO5	Design resource-oriented services by structuring resources, representations, and links based on client requirements.	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	PO4	PO5
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

1-low, 2-medium, 3-high

Chairman (BoS)

BD24E06	HIGH PERFORMANCE COMPUTING FOR BIG DATA (PROFESSIONAL ELECTIVES – I and II)	Category	L	T	P	SL	C
		PEC	45	0	0	45	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:

To equip students with the skills to design secure, high-performance big data solutions using real-time analytics and emerging technologies

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.

L:45, T:0, P:0, SL:45, TOTAL: 90 PERIODS

COURSE OUTCOMES:

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

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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

1-low, 2-medium, 3-high

Chairman (BoS)

CS24T18	NETWORK TECHNOLOGIES (PROFESSIONAL ELECTIVES – I and II)	Category	L	T	P	SL	C
		PCC	45	0	0	45	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:

To provide a comprehensive understanding of traditional and wireless networking concepts, mobile data networks (4G to 6G), Software Defined Networking (SDN), and Network Functions Virtualization (NFV), enabling students to design and analyze modern communication infrastructures.

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.

L:45, T:0, P:0, SL:45, TOTAL: 90 PERIODS

Chairman (BoS)

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

COs	Course Outcome	Cognitive Level
CO1	Identify and apply core networking concepts, devices and protocols to basic network configurations and operations.	Understand
CO2	Familiarize with and assess various wireless network technologies and standards.	Understand
CO3	Examine and critique mobile network technologies and protocols, including 4G, 5G, and emerging 6G systems.	Apply
CO4	Interpret and implement the principles and architecture of Software Defined Networking (SDN).	Apply
CO5	Outline 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	PO4	PO5
CO1	3	1	1	2	2
CO2	3	1	1	2	2
CO3	3	1	1	2	2
CO4	3	1	1	2	2
CO5	3	1	1	2	2

1-low, 2-medium, 3-high

Chairman (BoS)

BD24E07	DATA INTENSIVE COMPUTING (PROFESSIONAL ELECTIVES – I and II)	Category	L	T	P	SL	C
		PEC	45	0	0	45	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:

To provide a comprehensive understanding of distributed systems and data-intensive computing, including high-performance architectures, efficient processing techniques, security measures, and emerging 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.

L:45, T:0, P:0, SL:45, TOTAL: 90 PERIODS

COURSE OUTCOMES:

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

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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	Describe 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

1-low, 2-medium, 3-high

Chairman (BoS)

BD24E08	INTERNET OF THINGS (PROFESSIONAL ELECTIVES – III and IV)	Category	L	T	P	SL	C
		PCC	45	0	0	45	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:

To provide students with a foundational understanding of the Internet of Things (IoT), including its core technologies, system development using hardware and software tools, communication protocols, cloud integration and industrial 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.

L:45, T:0, P:0, SL:45, TOTAL: 90 PERIODS

COURSE OUTCOMES:

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

Chairman (BoS)

COs	Course Outcome	Cognitive Level
CO1	Describe the fundamental concepts, architecture, and technologies underlying the Internet of Things.	Understand
CO2	Build simple IoT systems using Raspberry Pi, sensors, actuators, and Python programming.	Apply
CO3	Outline the IoT communication protocols like 6LoWPAN, Zigbee, Bluetooth, and CoAP.	Understand
CO4	Develop cloud platforms and APIs to develop integrated IoT applications with real-time capabilities.	Apply
CO5	Apply IIoT concepts to industrial use cases involving edge computing and cloud-based solutions.	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	PO4	PO5
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

1-low, 2-medium, 3-high

Chairman (BoS)

CS24E09	FULL STACK WEB APPLICATION DEVELOPMENT (PROFESSIONAL ELECTIVES – III and IV)	Category	L	T	P	SL	C
		PEC	45	0	0	45	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:

To equip students with the skills to design and develop modern web applications using front-end and back-end technologies such as JavaScript, TypeScript, Angular, Node.js, Express.js and MongoDB.

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.

L:45, T:0, P:0, SL:45, TOTAL: 90 PERIODS

COURSE OUTCOMES:

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

Chairman (BoS)

COs	Course Outcome	Cognitive Level
CO1	interpret core concepts of JavaScript and TypeScript including data types, objects, classes, and interfaces.	Understand
CO2	Apply Angular features such as data binding, directives, and component lifecycle in front-end development.	Apply
CO3	Build and manage server-side applications using Node.js with events, callbacks, and HTTP/socket services	Apply
CO4	Use Express.js for routing, middleware configuration, and request/response handling in web apps.	Apply
CO5	Integrate and manipulate MongoDB with Node.js for NoSQL data storage and operations	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	PO4	PO5
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

1-low, 2-medium, 3-high

Chairman (BoS)

CS24E10	DEEP LEARNING (PROFESSIONAL ELECTIVES – III and IV)	Category	L	T	P	SL	C
		PEC	45	0	0	45	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:

To equip students with foundational knowledge and practical skills in deep learning, including neural network design, CNNs for image processing, NLP with RNNs, and advanced techniques such as 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 – Hyper parameters.

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.

L:45, T:0, P:0, SL:45, TOTAL: 90 PERIODS

COURSE OUTCOMES:

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

Chairman (BoS)

COs	Course Outcome	Cognitive Level
CO1	Infer proficiency in deep learning principles and the ability to manage various data types.	Understand
CO2	Describe the process of building and tuning neural networks using 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	PO4	PO5
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

1-low, 2-medium, 3-high

Chairman (BoS)

BD24E09	BLOCKCHAIN TECHNOLOGIES (PROFESSIONAL ELECTIVES – III and IV)	Category	L	T	P	SL	C
		PEC	45	0	0	45	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:

To introduce the core concepts of blockchain technology, explore various cryptocurrencies, and understand key mechanisms like double spending prevention, Bitcoin, Ethereum, and smart contract 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.

L:45, T:0, P:0, SL:45, TOTAL: 90 PERIODS

COURSE OUTCOMES:

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

Chairman (BoS)

COs	Course Outcome	Cognitive Level
CO1	Summarize the fundamentals of blockchain technology, its working, key features and differences from Bitcoin.	Understand
CO2	Outline the architecture, types and real-world applications of blockchain and cryptocurrencies.	Understand
CO3	Describe the concept of double spending and the role of cryptographic techniques like hashing, mining and Merkle trees	Understand
CO4	Demonstrate knowledge of Bitcoin operations, wallets, transactions and currency conversion.	Apply
CO5	Illustrate Ethereum's features, smart contracts, applications and the future of blockchain in domains like healthcare and DNS.	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	PO4	PO5
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

1-low, 2-medium, 3-high

Chairman (BoS)

CS24E11	NATURAL LANGUAGE PROCESSING (PROFESSIONAL ELECTIVES – III and IV)	Category	L	T	P	SL	C
		PEC	45	0	0	45	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:

To provide foundational knowledge and practical skills in natural language processing, covering text classification, parsing, semantic analysis, information extraction, and the development of dialogue and question-answering systems.

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.

L:45, T:0, P:0, SL:45, TOTAL: 90 PERIODS

COURSE OUTCOMES:

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

Chairman (BoS)

COs	Course Outcome	Cognitive Level
CO1	Outline comprehension of NLP basics, linguistics and tokenization techniques.	Understand
CO2	Implement statistical models for text classification, sequence labeling and vector semantics evaluation.	Apply
CO3	Analyze parsing techniques using contextual embeddings and grammars, including dependency and constituency parsing.	Analyze
CO4	Describe computational semantic techniques such as word sense disambiguation, semantic role labeling, and information extraction.	Understand
CO5	Illustrate methods in discourse analysis, question answering, and the design of dialogue systems.	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	PO4	PO5
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

1-low, 2-medium, 3-high

Chairman (BoS)

BD24E10	CYBER PHYSICAL SYSTEMS (PROFESSIONAL ELECTIVES – III and IV)	Category	L	T	P	SL	C
		PEC	45	3	0	45	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:

To introduce the concepts and design principles of Cyber-Physical Systems, focusing on safety, security, synchronization, system modeling and real-world applications using simulation 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.

L:45, T:0, P:0, SL:45, TOTAL: 90 PERIODS

Chairman (BoS)

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

COs	Course Outcome	Cognitive Level
CO1	Summarize the key features, components, and drivers of Cyber-Physical Systems to understand their structure and importance in modern applications	Understand
CO2	Examine synchronous and asynchronous CPS models, focusing on reactive components and coordination protocols.	Analyze
CO3	Apply safety and liveness specifications, using formal methods like model checking and temporal logic, to verify and validate CPS behavior.	Apply
CO4	Implement CPS models using continuous, linear, timed, and hybrid dynamical systems, with appropriate control and analysis techniques.	Apply
CO5	Explore CPS foundations like scheduling, security, and synchronization, and analyze their impact on system reliability.	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	PO4	PO5
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

1-low, 2-medium, 3-high

Chairman (BoS)

BD24E11	IMAGE AND VIDEO ANALYTICS (PROFESSIONAL ELECTIVES – III and IV)	Category	L	T	P	SL	C
		PEC	45	0	0	45	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:

To study core principles of image representation and analysis, explore preprocessing and enhancement techniques, and develop deep learning-based solutions for object detection, face and gesture recognition, and video analytics.

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.

L:45, T:0, P:0, SL:45, TOTAL: 90 PERIODS

COURSE OUTCOMES:

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

COs	Course Outcome	Cognitive Level

Chairman (BoS)

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

Chairman (BoS)

CS24E13	QUANTUM COMPUTING (PROFESSIONAL ELECTIVES – III and IV)	Category	L	T	P	SL	C
		PEC	45	0	0	45	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.

OBJECTIVES:

To introduce the principles of quantum computing by studying qubit systems, quantum operations, algorithm design, error correction strategies, and secure communication protocols such as quantum cryptography and teleportation.

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 Super positions – 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.

L:45, T:0, P:0, SL:45, TOTAL: 90 PERIODS

COURSE OUTCOMES:

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

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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	PO4	PO5
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

1-low, 2-medium, 3-high

Chairman (BoS)

BD24E12	INFORMATION RETRIEVAL TECHNIQUES (PROFESSIONAL ELECTIVES – III and IV)	Category	L	T	P	SL	C
		PEC	45	0	0	45	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:

To provide a comprehensive understanding of Information Retrieval by exploring foundational concepts, retrieval models, indexing techniques, text classification and clustering algorithms, and advanced methods including web search, link analysis, and multimedia 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.

L:45, T:0, P:0, SL:45, TOTAL: 90 PERIODS

COURSE OUTCOMES:

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

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COs	Course Outcome	Cognitive Level
CO1	Describe the architecture and process of Information Retrieval 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	PO4	PO5
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

1-low, 2-medium, 3-high

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BD24E13	WEB ANALYTICS (PROFESSIONAL ELECTIVES – III and IV)	Category	L	T	P	SL	C
		PEC	45	0	0	45	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:

To study the evolution of web analytics and address current challenges by developing practical solutions for clickstream analysis, competitive intelligence, social, mobile, and video analytics, while ensuring data quality and accuracy

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.

L:45, T:0, P:0, SL:45, TOTAL: 90 PERIODS

COURSE OUTCOMES:

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

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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

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BD24E14	DEVOPS AND MICROSERVICES (PROFESSIONAL ELECTIVES –V)	Category	L	T	P	SL	C
		PEC	45	0	0	45	3

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

PREREQUISITE

Basic knowledge in any programming languages, automation tools and cloud services are needed. In addition, knowledge in Machine learning helps to deploy it in real world problems.

OBJECTIVES:

This course aims to introduce the fundamental concepts and terminology of DevOps, including its platforms and automation tools. It helps learners understand the processes involved in code building, integration, and deployment. The course also provides basic insights into MLOps and its role in modern development practices.

UNIT – I	INTRODUCTION	(9)

Software Engineering – Traditional and Agile process models – DevOps – Definition – Practices – DevOps life cycle process – Need for DevOps – Barriers

– UNIT – II	DEVOPS PLATFORM AND SERVICES	(9)

Cloud as a platform – IaaS, PaaS, SaaS – Virtualization – Containers – Supporting Multiple Data Centers –Operation Services – Hardware provisioning – software Provisioning – IT services – SLA – capacity planning – security – Service Transition – Service Operation Concepts.

UNIT – III	BUILDING, TESTING AND DEPLOYMENT	(9)

Microservices architecture – Coordination model – Building and testing – Deployment pipeline – Development and Pre-Commit Testing – Build and Integration Testing – Continuous integration – Monitoring – Security – Resources to Be Protected – Identity Management

UNIT – IV	DEVOPS AUTOMATION TOOLS	(9)

Infrastructure Automation – Configuration Management – Deployment Automation – Performance Management – Log Management – Monitoring

UNIT – V	MLOPS	(9)

MLOps – Definition – Challenges – Developing Models – Deploying to production – Model Governance – Real world examples.

L:45, T:0, P:0, SL:45, TOTAL: 90 PERIODS

COURSE OUTCOMES:

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

COs	Course Outcome	Cognitive Level
CO1	Describe the key concepts of DevOps, its lifecycle, practices, and the need for adopting DevOps over traditional models	Understand
CO2	Implement cloud-based DevOps solutions using service models such as IaaS, PaaS, and SaaS to support IT operations and service delivery	Apply

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CO3	Illustrate the process of building, testing, and deploying applications using continuous integration and microservices architecture	Understand
CO4	Apply DevOps automation tools for infrastructure management, performance monitoring and automated deployment.	Apply
CO5	Summarize the principles of MLOps, including model development, deployment and governance in real-world scenarios	Understand

REFERENCES:

1. Len Bass, Ingo Weber and Liming Zhu, DevOps: A Software Architect's Perspective, Pearson Education, First Edition, 2016
2. Joakim Verona, Practical DevOps, Packet Publishing, Second Edition, 2018
3. Viktor Farcic, The DevOps 2.1 Toolkit: Docker Swarm, Packet Publishing, First Edition, 2017
4. Mark Treveil, and the Dataiku Team, Introducing MLOps, O'Reilly Media, First Edition, 2020.
5. Kalpesh Parikh and Amit Johri, Combining DataOps, MLOps and DevOps, BPB Publication, India, First Edition, 2022.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5
CO1	3	2	1	3	3
CO2	3	2	1	3	3
CO3	3	2	1	3	3
CO4	3	2	1	3	3
CO5	3	2	1	2	3

1-low, 2-medium, 3-high

Chairman (BoS)

CS24T36	SOFT COMPUTING (PROFESSIONAL ELECTIVES –V)	Category	L	T	P	SL	C
		PCC	45	0	0	45	3

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

PREREQUISITE

Basic knowledge of mathematics, programming and fundamentals of AI or machine learning is required. Understanding of logic and algorithms is also helpful.

OBJECTIVES:

To introduce the fundamentals of soft computing and its key techniques such as fuzzy logic, neural networks, and genetic algorithms. It focuses on the application of these techniques in solving complex, real-world problems. Students will also explore hybrid models like neuro-fuzzy systems and their practical use cases.

UNIT – I	INTRODUCTION TO SOFT COMPUTING	(9)

Introduction to soft computing – Evolution of Computing – Soft computing vs. Hard computing – Types of soft computing techniques – From Conventional AI to Computational Intelligence: Machine Learning Basics.

UNIT – II	FUZZY LOGIC	(9)

Fuzzy Sets – Operations on Fuzzy Sets – Fuzzy Relations – Membership Functions: Fuzzy Rules and Fuzzy Reasoning – Fuzzy Inference Systems – Fuzzy Expert Systems – Fuzzy Decision Making.

UNIT – III	NEURAL NETWORKS	(9)

Machine Learning Using Neural Network – Adaptive Networks – Feed forward Networks – Supervised Learning Neural Networks – Radial Basis Function Networks: Reinforcement Learning – Unsupervised Learning Neural Networks – Adaptive Resonance architectures – Advances in Neural networks

UNIT – IV	GENETIC ALGORITHMS	(9)

Genetic Algorithms: Basic Concepts – Basic Operators for Genetic Algorithms – Crossover and Mutation Properties – Genetic Algorithm Cycle – Fitness Function – Applications of Genetic Algorithm.

UNIT – V	NEURO-FUZZY MODELING	

Adaptive Neuro-Fuzzy Inference Systems – Coactive Neuro-Fuzzy Modeling – Classification and Regression Trees – Data Clustering Algorithms – Rule Based Structure Identification – Neuro-Fuzzy Control – Case Studies.

L:45, T:0, P:0, SL:45, TOTAL: 90 PERIODS

COURSE OUTCOMES:

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

COs	Course Outcome	Cognitive Level
CO1	Identify the key characteristics of soft computing techniques and differentiate them from hard computing approaches	Understand

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CO2	Apply fuzzy logic and reasoning to handle uncertainty and solve various engineering problems.	Apply
CO3	Discuss the structure and functioning of various neural networks and their role in machine learning	Understand
CO4	Use genetic algorithm operators and fitness functions to perform optimization tasks.	Apply
CO5	Describe the components and working of neuro-fuzzy systems used in classification and control applications.	Understand

REFERENCES:

1. S. N. Sivanandam & S. N. Deepa, "Principles of Soft Computing", 3rd edition, Wiley India,2018
2. N.P. Padhy, S.P. Simon, Soft Computing with MATLAB Programming, 1st Edition, Oxford Higher Education, 2015.
3. Samir Roy, Udit Chakraborty, Introduction to Soft Computing - Neuro – Fuzzy and Genetic Algorithms, 1st Edition, Pearson, 2013.
4. D. K. Pratihar, Soft Computing: Fundamentals and Applications, Alpha Science International Ltd, 1st Edition, 2013.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5
CO1	3	2	2	2	2
CO2	3	2	2	2	2
CO3	3	2	2	2	2
CO4	3	2	2	2	2
CO5	3	2	2	2	2

1-low, 2-medium, 3-high

Chairman (BoS)

BD24E15	HEALTHCARE ANALYTICS (PROFESSIONAL ELECTIVES –V)	Category	L	T	P	SL	C
		PEC	45	0	0	45	3

PREREQUISITE

Students should understand statistics, machine learning, and deep learning concepts. Familiarity with healthcare systems, EHR and compliance (HIPAA, GDPR) is essential. Knowledge of SQL, Python/R, data visualization and big data tools is recommended.

OBJECTIVES:

To introduce students to healthcare data analytics, covering data sources, image and text analysis, predictive modeling, and visualization techniques for effective clinical decision-making. The course also emphasizes practical applications and challenges in handling real-world healthcare data.

UNIT – I	HEALTHCARE ANALYTICS AND DATA SOURCES	(9)

Introduction to Healthcare Data Analytics: Introduction – Healthcare Data Sources and Basic Analytics – Advanced Data Analytics for Healthcare – Applications and practical systems for Healthcare – Resources for healthcare data analytics. Electronic Health Records: Introduction – History Components – Coding Systems – Benefits – Barrier – Challenges – Phenotyping Algorithms.

UNIT – II	HEALTHCARE IMAGE AND TEXT DATA ANALYTICS	(9)

Biomedical Image Analysis: Introduction – Modalities – Object Detection – Image Segmentation – Image Registration – Feature Extraction. Natural Language Processing: Introduction – Natural Language Processing – Mining Information from Clinical Text – Challenges of Processing Clinical Reports – Clinical Applications.

UNIT – III	BIOMEDICAL AND SOCIAL MEDIA DATA ANALYTICS	(9)

Mining the Biomedical Literature: Introduction – Resources – Terminology Acquisition and Management – Information Extraction – Discourse Interpretation – Text Mining Environments – Applications – Integration with Clinical Text Mining. Social Media Analytics for Healthcare: Introduction – Detection and Tracking of Infectious Disease – Public Health Research – Use in Healthcare.

UNIT – IV	CLINICAL PREDICTION MODELS	(9)

Review of Clinical Prediction Models: Introduction – Basic Statistical Prediction Models: Linear Regression – Generative Additive Model – Logistic Regression – Bayesian Models – Markov Random Fields – Alternative Clinical Prediction Models – Survival Models – Evaluation and Validation: Evaluation Metrics – Validation.

UNIT – V	TEMPORAL AND VISUAL DATA ANALYTICS	(9)

Temporal Data Mining for Healthcare Data: Introduction – Association Analysis – Temporal Pattern Mining – Sensor Data Analysis – Other Temporal Modeling Methods – Resources. Visual Analytics for Healthcare: Introduction to Visual Analytics and Medical Data Visualization – Visual Analytics in Healthcare.

L:45, T:0, P:0, SL:45, TOTAL: 90 PERIODS

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

COs	Course Outcome	Cognitive Level
CO1	Describe the sources of healthcare data and explain the components, benefits, and challenges of electronic health records.	Understand
CO2	Utilize biomedical image analysis and natural language processing techniques to extract relevant clinical information.	Apply
CO3	Analyze biomedical literature and social media data to support public health insights and healthcare applications.	Analyze
CO4	Implement statistical and machine learning methods to build and validate clinical prediction models.	Apply
CO5	Employ temporal and visual data analytics to identify trends and patterns in healthcare data.	Apply

REFERENCES:

1. Chandan K.Reddy, Charu C. Aggarwal, Health Care data Analysis, CRC, First Edition, 2015.
2. Vikas Kumar, Health Care Analysis Made Simple, Packt Publishing, First Edition, 2018.
3. Nilanjan Dey, Amira Ashour, Simon James Fong, Chintan Bhatl, Health Care Data Analysis and Management, Academic Press, First Edition, 2018.
4. Hui Jang, Eva K.Lee, HealthCare Analysis: From Data to Knowledge to Healthcare Improvement, Wiley, First Edition, 2016.
5. Kulkarni, Siarry, Singh, Abraham, Zhang, Zomaya, Baki, Big Data Analytics in HealthCare Second, Springer, 2020.

Mapping of COs with POs and PSOs

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

1-low, 2-medium, 3-high

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BD24E16	PREDICTIVE MODELLING (PROFESSIONAL ELECTIVES –V)	Category	L	T	P	SL	C
		PCC	45	0	0	45	3

PREREQUISITE

Basic knowledge of statistics, machine learning and python programming is required. Familiarity with data preprocessing and data mining is recommended.

OBJECTIVES

To equip students with the knowledge and skills to build, evaluate, and apply predictive models using statistical and machine learning techniques for solving real-world data analysis problems.

UNIT – I	INTRODUCTION TO PREDICTIVE MODELING	(9)

Core ideas in data mining – Supervised and unsupervised learning – Classification vs. Prediction – Steps in data mining – SEMMA Approach – Sampling – Pre-processing – Data cleaning – Data Partitioning – Building a model – Statistical models – Statistical models for predictive analytics.

UNIT – II	PREDICTIVE MODELING BASICS	(9)

Data splitting – Balancing – Over fitting – Oversampling – Multiple Regression Artificial neural networks (MLP) – Variable importance – Profit/loss/prior probabilities – Model specification – Model selection – Multivariate Analysis.

UNIT – III	PREDICTIVE MODELS	(9)

Association Rules – Clustering Models – Decision Trees – Ruleset Models – K Nearest Neighbors – Naive Bayes – Neural Network Model – Regression Models – Regression Trees – Classification & Regression Trees (CART) – Logistic Regression – Multiple Linear Regression Scorecards – Support Vector Machines – Time Series Models – Comparison between models – Lift chart Assessment of a single model.

UNIT – IV	PREDICTIVE MODELING MARKUP LANGUAGE	(9)

Introduction to PMML – PMML Converter – PMML Structure – Data Manipulation in PMML – PMML Modeling Techniques – Multiple Model Support – Model Verification.

UNIT – V	TECHNOLOGIES AND CASE STUDIES	(9)

Weka – RapidMiner – IBM SPSS Statistics- IBM SPSS Modeler – SAS Enterprise Miner – Apache Mahout – R Programming Language. Real time case study with modeling and analysis.

L:45, T:0, P:0, SL:45, TOTAL: 90 PERIODS

COURSE OUTCOMES:

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

COs	Course Outcome	Cognitive Level
CO1	Describe the core concepts of data mining and predictive modeling, including supervised and unsupervised learning techniques	Understand
CO2	Apply basic predictive modeling techniques such as regression and neural networks, and evaluate model performance using appropriate measures.	Apply

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CO3	Examine and compare various predictive models like decision trees, SVM, and logistic regression for classification and regression tasks.	Analyze
CO4	Interpret and represent predictive models using Predictive Modeling Markup Language (PMML) for model sharing and deployment.	Apply
CO5	Utilize predictive modeling tools like Weka, RapidMiner, and R to solve real-world problems through case studies.	Apply

REFERENCES:

1. Kattamuri S. Sarma, Predictive Modeling with SAS Enterprise Miner: Practical Solutions for Business Applications, Third Edition, SAS Publishing, 2017.
2. Alex Guazzelli, Wen-Ching Lin, Tridivesh Jena, James Taylor, PMML in Action Unleashing the Power of Open Standards for Data Mining and Predictive Analytics, Secod Edition, Create Space Independent Publishing Platform,2012.
3. Ian H. Witten, Eibe Frank, Data Mining: Practical Machine Learning Tools and Techniques, Morgan Kaufmann Series in Data Management Systems, Morgan Kaufmann, Third Edition, 2011.
4. Eric Siegel, Predictive Analytics: The Power to Predict Who Will Click, Buy, Lie, or Die, Second Edition, Wiley, 2016.
5. Conrad Carlberg, Predictive Analytics: Microsoft Excel, First Edition, Que Publishing, 2012.

Mapping of COs with POs and PSOs

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

1-low, 2-medium, 3-high

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BD24E17	SOCIAL NETWORK ANALYSIS (PROFESSIONAL ELECTIVES –V)	Category	L	T	P	SL	C
		PEC	45	0	0	45	3

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

PREREQUISITE

Students should know basic data structures, especially graphs. They should be familiar with Python and using tools like NetworkX. A basic idea of statistics and probability will also be useful.

OBJECTIVES:

The course aims to introduce the theoretical foundations and practical tools used in Social Network Analysis. It enables students to explore network models, centrality measures, link analysis, and community structures. Students will also learn about information diffusion, privacy concerns, and real-world applications using tools like NetworkX and Gephi.

UNIT – I	FOUNDATIONS OF SOCIAL NETWORKS	(9)

Introduction to Social Networks –Types of Networks: Social, Information, Biological – Graph Theory Basics: Nodes, Edges, Degree – Paths, Cycles, and Network Representation – Network Visualization using NetworkX – Bipartite and Ego Networks.

UNIT – II	NETWORK MODELS AND MEASURES	(9)

Random Graph Model – Small-world Model – Scale-Free Networks – Degree Distribution and Network Growth – Clustering Coefficient and Network Robustness – Distance Measures and Components.

UNIT – III	CENTRALITY AND LINK ANALYSIS	(9)

Degree, Closeness, and Betweenness Centrality – Eigenvector Centrality and PageRank – HITS Algorithm – Introduction to Link Analysis – Link Prediction Techniques – Applications of Centrality in Real Networks.

UNIT – IV	COMMUNITIES AND NETWORK COHESION	(9)

Community Detection Overview – Girvan-Newman Algorithm – Louvain and Label Propagation Methods – Network Cohesion and k-Cliques – Structural Equivalence and Subgroups – Brokerage and Role of Ego Networks.

UNIT – V	INFORMATION DIFFUSION, SECURITY & TOOLS	(9)

Information Diffusion Models (SI, SIR) – Independent Cascade and Linear Threshold Models – Privacy and Security in Social Networks – De-anonymization and Privacy Preservation – Ethical and Legal Issues in SNA – Tools: NetworkX, Gephi, iGraph.

L:45, T:0, P:0, SL:45, TOTAL: 90 PERIODS

COURSE OUTCOMES:

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

COs	Course Outcome	Cognitive Level
CO1	Identify different types of networks and interpret basic graph concepts such as nodes, edges, and paths using visualization tools.	Understand

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CO2	Apply various network models to analyze structural properties like clustering and robustness in real-world networks.	Apply
CO3	Analyze centrality measures and link analysis algorithms to determine node importance in social networks.	Analyze
CO4	Compare different community detection techniques and discuss their role in identifying cohesive subgroups in networks.	Understand
CO5	Demonstrate how diffusion models and privacy techniques are used to manage information spread and security in networks.	Apply

REFERENCES:

1. Niyati Aggrawal & Adarsh Anand, Social Networks: Modelling and Analysis, CRC Press, First Edition,2022.
2. John Scott, John McLevey & Peter J. Carrington, The SAGE Handbook of Social Network Analysis, SAGE Publications, Second Edition,2023.
3. Charu C. Aggarwal, Social Network Data Analytics, Springer, First Edition, 2011.
4. Peter Mika, Social Networks and the Semantic Web, Springer, First Edition, 2007.
5. BorkoFurht, Handbook of Social Network Technologies and Applications, Springer, First Edition, 2010.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5
CO1	2	2	1	2	2
CO2	2	2	1	2	2
CO3	2	2	1	2	2
CO4	2	2	1	2	2
CO5	2	2	1	2	2

1-low, 2-medium, 3-high

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AX24A01	DISASTER MANAGEMENT	Category	L	T	P	SL	C
		AC	30	0	0	0	0

(Common to All Branches)

PREREQUISITE:

A basic understanding of geography, environmental science and public health is a prerequisite for studying disaster management.

OBJECTIVES:

To enable students to understand the nature, causes, and impacts of natural and manmade disasters, identify disaster prone areas with special reference to India and develop knowledge on disaster preparedness, management strategies, risk assessment techniques and sustainable approaches for effective disaster mitigation and community resilience.

UNIT - I	INTRODUCTION	(6)

Disaster: Definition, Factors and Significance; Difference between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT - II	REPERCUSSIONS OF DISASTERS AND HAZARDS	(6)

Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease and Epidemics, War and Conflicts.

UNIT - III	DISASTER PRONE AREAS IN INDIA	(6)

Study of Seismic Zones; Areas Prone to Floods and Droughts, Landslides and Avalanches; Areas Prone to Cyclonic and Coastal Hazards with Special Reference to Tsunami; Post-Disaster Diseases and Epidemics.

UNIT - IV	DISASTER PREPAREDNESS AND MANAGEMENT	(6)

Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological and Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT - V	RISK ASSESSMENT	(6)

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Green economy, Blue economy, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment, Strategies for Survival.

L:30, T:0, P:0, SL:0, TOTAL: 30 PERIODS

COURSE OUTCOMES:

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

COs	Course Outcome	Cognitive Level
CO1	Understand the definitions, differences, and classifications of disasters and hazards	Understand
CO2	Discuss the destruction of ecosystems and the loss of human and animal life resulting from different disaster events.	Understand
CO3	Compare the vulnerability of different regions in India to various natural disasters.	Understand

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CO4	Summarize the methods and technologies used in assessing and monitoring disaster risks.	Understand
CO5	Describe the concept, elements, and current global and national scenarios of disaster risk.	Understand

TEXT BOOKS:

1. Gupta, Harsh K., "Disaster Management", Universities Press, Hyderabad, 2nd Edition, 2013.
2. Satendra, "Disaster Management in India: Perspectives, Issues and Strategies", National Institute of Disaster Management, New Delhi, 1st Edition, 2018.

REFERENCES:

1. Goel S. L., "Disaster Administration and Management Text and Case Studies", Deep & Deep Publication Pvt. Ltd., New Delhi, 2009.
2. Nishitha Rai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies" New Royal book Company, 2007.
3. Sahni, Pardeep et.al., "Disaster Mitigation Experiences and Reflections", Prentice Hall of India, New Delhi, 2001.
4. Sharma, R.K. and Sharma, G. "Natural Disaster Management: Causes, Effects and Mitigation", Deep & Deep Publications, New Delhi, 2005.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5
CO1	1	1	1	-	-
CO2	1	1	1	-	-
CO3	1	1	1	-	-
CO4	1	1	1	-	-
CO5	1	1	1	-	-

1-low, 2-medium, 3-high

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AX24A02	VALUE EDUCATION	Category	L	T	P	SL	C
		AC	30	0	0	0	0

(Common to All Branches)

PREREQUISITE:

Basic understanding of moral principles, social responsibilities, and a willingness to engage in self-reflection and personal growth.

OBJECTIVES:

To foster self-development, strengthen human values, and promote overall personality growth and social empowerment through value-based education.

UNIT - I	INTRODUCTION TO VALUE EDUCATION	(6)

Values and self-development – Social values and individual attitudes, Work ethics, Indian vision of humanism, Moral and non- moral valuation, Standards and principles, Value judgements.

UNIT - II	IMPORTANCE OF VALUES	(6)

Importance of cultivation of values, Sense of duty, Devotion, Self-reliance, Confidence, Concentration, Truthfulness, Cleanliness. Honesty, Humanity, Power of faith, National Unity, Patriotism, Love for nature, Discipline

UNIT - III	INFLUENCE OF VALUE EDUCATION	(6)

Personality and Behaviour development - Soul and Scientific attitude. Positive Thinking, Integrity and discipline, Punctuality, Love and Kindness, avoid fault Thinking, Free from anger, Dignity of labour, Universal brotherhood and religious tolerance, True friendship Happiness Vs suffering, love for truth.

UNIT - IV	REINCARNATION THROUGH VALUE EDUCATION	(6)

Aware of self-destructive habits, Association and Cooperation, Doing best for saving nature Character and Competence – Holy books vs Blind faith, Self-management and good health, Science of reincarnation

UNIT - V	VALUE EDUCATION IN SOCIAL EMPOWERMENT	(6)

Equality, Nonviolence, Humility, Role of Women, all religions and same message, mind your Mind, Self-control, Honesty, Studying effectively

L:30, T:0, P:0, SL:0, TOTAL: 30 PERIODS

COURSE OUTCOMES:

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

COs	Course Outcome	Cognitive Level
CO1	Gain knowledge of self-development.	Understand
CO2	Learn the importance of Human values.	Understand
CO3	Develop the overall personality through value education.	Understand
CO4	Overcome the self-destructive habits with value education.	Understand
CO5	Interpret social empowerment with value education.	Understand

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TEXT BOOKS:

1. Chakravarthy.S.K. "Values and Ethics for organizations Theory and practice", Oxford University Press, New Delhi, 1999.
2. M.G. Chitakra, "Education and Human Values", A.P.H. Publishing Corporation, New Delhi, 2003.

REFERENCES:

1. Satchidananda, M.K, "Ethics, Education, Indian Unity and Culture", Ajantha Publications, Delhi, 1991.
2. Das, M.S., Gupta, V.K. "Social Values among Young adults: A changing Scenario", M.D. Publications, New Delhi, 1995.
3. Bandiste, D.D., "Humanist Values: A Source Book", B.R. Publishing Corporation, Delhi, 1999
4. Ruhela, S.P., "Human Values and education", Sterling Publications, New Delhi, 1986

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5
CO1	2	1	2	-	-
CO2	2	1	2	-	-
CO3	2	1	2	-	-
CO4	2	1	2	-	-
CO5	2	1	2	-	-

1-low, 2-medium, 3-high

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AX24A03	CONSTITUTION OF INDIA	Category	L	T	P	SL	C
		AC	30	0	0	0	0

(Common to All Branches)

PREREQUISITE:

Basic awareness of Indian history, civics, and political system at the school level, along with interest in understanding the democratic framework and governance of India.

OBJECTIVES:

To provide a comprehensive understanding of the India Constitution, including its basic structure, fundamental rights and duties, directive principles, the functioning of the Union and State governments, and the electoral system.

UNIT - I	INTRODUCTION TO INDIAN CONSTITUTION	(6)

Indian Constitution: Necessity of the Constitution, Societies before and after the Constitution adoption. Introduction to the Indian constitution, Making of the Constitution, Role of the Constituent Assembly.

UNIT - II	FUNDAMENTAL RIGHTS AND DUTIES	(6)

Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT - III	UNION GOVERNMENT	(6)

Parliamentary System, Union Executive – President, Prime Minister, Union Cabinet, Parliament - LS and RS, Parliamentary Committees, Important Parliamentary Terminologies. Supreme Court of India, Judicial Reviews and Judicial Activism.

UNIT - IV	STATE GOVERNMENT	(6)

State Government – Structure and Functions – Governor – Chief Minister – Cabinet – State Legislature – Judicial System in States – High Courts and other Subordinate Courts.

UNIT - V	ELECTION COMMISSION	(6)

Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.

L:30, T:0, P:0, SL:0, TOTAL: 30 PERIODS

COURSE OUTCOMES:

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

COs	Course Outcome	Cognitive Level
CO1	Understand the basic structure of Indian Constitution.	Understand
CO2	Remember their Fundamental Rights, DPSP's and Fundamental Duties (FD's) of our constitution.	Understand
CO3	Know about our Union Government, political structure & codes, procedures.	Understand
CO4	Understand our State Executive of India.	Understand
CO5	Understand our Elections system of India.	Understand

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TEXT BOOKS:

1. Durga Das Basu, "Introduction to the Constitution of India", Lexis Nexis Publisher, New Delhi, 23rd edition, 2018.
2. P.M. Bakshi, "The Constitution of India", Universal law Publishing, New Delhi, Fifteenth Edition, 2018.

REFERENCES:

1. Brij Kishore sharma, "Introduction to the constitution india", PHI Learning Pvt. Ltd, New Delhi, Seventh Edition, 2015.
2. M. Laxmikanth, "Indian Polity", Tata McGraw Hill, New Delhi, Sixth Edition, 2017.
3. P. K. Agarwal, "Constitution of India", Prabhat Publishers, New Delhi, Second Edition, 2015.
4. M.P. Jain, "Indian Constitution Law", Lexis Nexis Publisher, New Delhi, 7th Edition, 2014.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5
CO1	2	1	2	-	-
CO2	2	1	2	-	-
CO3	2	1	2	-	-
CO4	2	1	2	-	-
CO5	2	1	2	-	-
Avg.	2	1	2	-	-

1-low, 2-medium, 3-high

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AX24A04	INDIAN KNOWLEDGE SYSTEM	Category	L	T	P	SL	C
		AC	30	0	0	0	0

(Common to All Branches)

PREREQUISITE:

Basic knowledge of Indian history and culture, and an interest in exploring traditional systems of knowledge across disciplines such as science, technology, humanities, and philosophy.

OBJECTIVES:

To provide an understanding of the historical evolution, key features, and multidisciplinary applications of the Indian Knowledge System, encompassing its contributions to humanities, science, engineering, socio-religious practices, and the need for its protection and preservation.

UNIT - I	INTRODUCTION TO INDIAN KNOWLEDGE SYSTEM	(6)

Importance of Ancient Knowledge System, Definition, concept, and scope of Indian Knowledge System (IKS), IKS based approaches on knowledge paradigms, IKS in modern India, Some unique Aspects of IKS.

UNIT - II	TRADITIONAL KNOWLEDGE IN HUMANITIES AND SCIENCES	(6)

Linguistics, Number and measurements - Mathematics, Chemistry, Physics, Art, Astronomy, Astrology, Crafts and Trade in India and Engineering and Technology.

UNIT - III	TRADITIONAL KNOWLEDGE IN PROFESSIONAL DOMAIN	(6)

Town planning and architecture Construction, Health, wellness and Psychology – Medicine, Agriculture, Governance and public administration, United Nations Sustainable development goals.

UNIT - IV	APPLIED TRADITIONAL KNOWLEDGE	(6)

Myths, Rituals, Spirituals, Taboos and Belief System, Folk Stories, Songs, Proverbs, Dance, Play, Acts and Traditional Narratives, Agriculture, animal husbandry, Forest, Sacred Groves, Water Mills, Sacred Water Bodies, Land, water and Soil Conservation and management Practices, Indigenous Bio-resource Conservation, Utilization Practices and Food Preservation Methods, Handicrafts, Wood Processing and Carving, -Fiber Extraction and Costumes

UNIT - V	PROTECTION OF INDIAN KNOWLEDGE SYSTEM	(6)

Documentation and Preservation of IKS, approaches for conservation and Management of nature and bio-resources, Approaches and strategies to protection and conservation of IKS.

L:30, T:0, P:0, SL:0, TOTAL: 30 PERIODS

COURSE OUTCOMES:

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

COs	Course Outcome	Cognitive Level
CO1	Explain the historicity of Indian Knowledge System.	Understand
CO2	Explain the features of traditional knowledge in humanities and sciences.	Understand
CO3	Develop familiarity with science, engineering and technology of IKS	Understand
CO4	Understand the importance of functional, aesthetic, and socio-religious concept of IKS.	Understand
CO5	Understand the concepts of protection of IKS.	Understand

TEXT BOOKS:

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1. B Mahadevan, Vinayak Rajat Bhat, Nagendra Pavana R N, "Introduction to India Knowledge System Concepts and Applications", PHI Learning Private Ltd, 2022, ISBN-978-93-91818-21-0.
2. Amit Jha, "Traditional Knowledge System in India", Atlantic Publishers and Distributors (P) Ltd., 2009, ISBN-13: 978-8126912230.

REFERENCES:

1. Kapil Kapoor, Avadesh Kumar Singh, "Knowledge Traditions and Practices of India" Vol. 1, DK Print World (P) Ltd., 2005, ISBN 81-246-0334.
2. D.N. Bose, S.N. Sen, B. V. Subbarayappa, "A Concise History of Science in India", Indian National Science Academy, New Delhi, 2009.
3. S. N. Sen, K. S. Shukla, "History of Astronomy in India", Indian National Science Academy, 2nd edition, New Delhi, 2000.
4. Dr. Ravindra Singh Rana, Indian Knowledge System of Materials in Science and Technology, Walnut Publication, 2023.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5
CO1	2	2	2	-	-
CO2	2	2	2	-	-
CO3	2	2	2	-	-
CO4	2	2	2	-	-
CO5	2	2	2	-	-

1-low, 2-medium, 3-high

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