COURSE BOOK M.TECH(CSE) I YEAR

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CURRICULUM STRUCTURE & SYLLABUS

Effective from the Session: 2025-26

M.Tech (CSE) 1st Sem

S No.	Course Category (AICTE)	Course Category (UGC)	BOS	Course Code	Course Name	Type	Academic Learning (AL)			Continuous Internal Examination (CIE)			End Sem Examination (ESE)	Total Marks	Total Credits
							L	T	P	MSE	CA	TOTAL		CIE+ ESE	
1	PC	Major (Core)	CSE	CS501L	Advanced Data Structures	L	4	0	0	80	20	100	100	200	4
2	PC	Major (Core)	CSE	CS502L	Data Science Foundation	L	4	0	0	80	20	100	100	200	4
3	PC	Major (Core)	CSE	CS503L	Advanced DBMS	L	4	0	0	80	20	100	100	200	4
4	PC	Major (Core)	CSE	CS504L	Advanced Software Engineering	L	3	0	0	60	15	75	75	150	3
5	PC	Major (Core)	CSE	CS405L	Research Methodology	L	3	0	0	60	15	75	75	150	3
6															
Lab/Practical															
7	PC	Major (Core)	CSE	CS501P	Advanced Data Structures Lab	P	0	0	2	-	50	50	-	50	1
8	PC	Major (Core)	CSE	CS502P	Data Science Foundation Lab	P	0	0	2	-	50	50	-	50	1
Total Hours : 22 hrs.							**18**	**0**	**4**					**1000**	**20**

M.Tech (CSE) 2nd Sem

S No.	Course Category (AICTE)	Course Category (UGC)	BOS	Course Code	Course Name	Type	Academic Learning (AL)			Continuous Internal Examination (CIE)			End Sem Examination (ESE)	Total Marks	Total Credits
							L	T	P	MSE	CA	TOTAL		CIE+ ESE	
1	PC	Major (Core)	CSE	CS5XXE	Elective 1	L	4	0	0	80	20	100	100	200	4
2	PC	Major (Core)	CSE	CS5XXE	Elective 2	L	3	0	0	60	15	75	75	150	3
3	PC	Major (Core)	CSE	CS506L	Scientific Writing, Ethics and IPR	L	3	0	0	60	15	75	75	150	3
Blended															
4	PC	Major (Core)	CSE	AI501B	Machine Learning	B	4	0	2	100	25	125	125	250	5
5	PC	Major (Core)	CSE	CS505B	Advanced in Data & Computer Communications	B	4	0	2	100	25	125	125	250	5
Total Hours : 22 hrs.							**18**	**0**	**4**					**1000**	**20**

Elective 1:
CS507E: Natural Language Processing (NLP)
CS512E: Advanced Java Programming
CS517E: Blockchain Technology

Elective 2:
CS508E: Advance Statistical Method
CS513E: DevOps
CS516E: Quantum Computing

Theory Courses Detail Syllabus

Course Code: CS501L	Course Name: Advanced Data Structures	L	T	P	C
		4	0	0	4

Pre-requisite: Fundamentals of Data Structures & Algorithm

Course Objectives:

1. Comprehensive understanding of advanced data structures, their applications, and design principles.
2. Ability to evaluate and analyze the efficiency of data structures for solving complex problems.
3. Hands-on experience in implementing advanced data structures through practical projects and programming assignments.

Course Outcome: After completion of the course, the student will be able to

1. Understand advanced physical data structures.
2. Explore the stack and queue data structures and its applications.
3. Explore the different variations of the Tree data structure and their characteristics
4. Demonstrate the representation and traversal techniques of graphs and their applications
5. Examine the different methods of searching and sorting to gain a deeper understanding of their distinct approaches and procedures.

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO-PO Mapping	PO1	PO2	PO3	PSO1	PSO2
CO1	0	1	3	3	2
CO2	1	0	2	3	2
CO3	1	0	3	3	2
CO4	1	0	2	3	2
CO5	1	0	2	3	2

Unit 1	Introduction to Advanced Data Structures	12 hours

Overview of advanced data structures and their importance, Analysis of time and space complexity, Amortized analysis, Representation of Arrays: Row Major Order, and Column Major Order, Derivation of Index Formulae for 3-D and n-D Array. Linked List: XOR Linked List, Applications on Single Linked list- Polynomial Expression Representation, Addition and Multiplication.

Unit 2	Stack and Queue	12 hours

ADTs and implementations using arrays and linked lists Stack and Queue, Stack implementation using Queue, Queue implementation using Stack, Priority Queues, Double Ended Queue, Circular Queue, Dequeued Stack

Unit 3	Trees	12 hours

Binary Search Trees, AVL Trees, 2-4 trees, Optimal binary search trees, B-Tree, Tries, Segment Trees, Fenwick Trees (Binary Indexed Trees), Suffix Tree. Threaded Binary trees, Traversing Threaded Binary trees., Fibonacci heaps, Splay trees

Unit 4	Graph	12 hours

Graph representations (adjacency list, adjacency matrix, etc.) Graph traversals (BFS, DFS), State-of-the-art algorithms for minimum spanning trees (Prim's, Kruskal's and Boruvka's algorithms), Shortest path algorithms (Dijkstra's algorithm, Bellman-Ford algorithm).

Unit 5	Searching and Sorting	12 hours

Introduction to stable, external, in-place and sorting. Hashing and Hash Tables, Heaps and Heap Sort, Quick sort and its randomized version, Counting Sort, Shell Sort.

Total Lecture Hours	60 hours

Textbook:

1. Cormen, Leiserson, Rivest, and Stein, Introduction to Algorithms (3 ed.), MIT Press, 2009. ISBN 978-0262033848.
2. Ellis Horowitz and Sartaj Sahni, Fundamentals of Data Structures (1 ed.), W H Freeman & Co, 1993. ISBN 9780716780427.
3. Lipschutz, "Data Structures" Schaum's Outline Series, Tata McGraw-hill Education (India) Pvt. Ltd.
4. AK Sharma, "Data Structure Using C", Pearson Education India.

Reference Books:

1. V. Aho, J. E. Hopcroft, and J. D. Ullman, Data Structures and Algorithms (1 ed.), Pearson, 1983. ISBN 978-0201000238
2. Dasgupta, Papadimitrou and Vazirani, Algorithms (3 ed.), McGraw-Hill Education, 2006. ISBN 978-0073523408.
3. Kleinberg and Tardos, Algorithm Design (1 ed.), Pearson, 2005. ISBN 978-0321295354

Mode of Evaluation						
MSE		CA			ESE	Total
MSE1 40	MSE2 40	CA1 8	CA2 8	CA3 (ATT) 4		
80		20			100	200

Course Code : CS502L	Course Name : Data Science Foundation	L	T	P	C
		4	0	0	4

Pre-requisite: NA

Course Objectives

1. To understand the concept of data science, its role in addressing big data challenges, and its importance across industries.
2. To develop proficiency in data manipulation and analysis using SQL, including basic statistics, filtering, joins, aggregation, and window functions.
3. To comprehend the principles of effective data visualization, utilize Tableau to create visualizations, and design interactive dashboards.

Course Outcome: After completion of the course, the student will be able to

1. Articulate the fundamentals of data science and its relevance in addressing big data challenges.
2. Apply data manipulation techniques using SQL, including basic statistical operations.
3. Acquire the concept of data preprocessing, cleaning, and transformation.
4. Understand the concept of python language for graph plotting.
5. Develop critical thinking by making data-driven decisions and effectively communicating their findings through visualizations.

CO-PO Mapping (scale 1: low, 2: Medium, 3: High)

CO-PO Mapping	PO1	PO2	PO3	PSO1	PSO2
CO1	1	0	1	2	1
CO2	1	2	1	2	2
CO3	2	2	2	2	2
CO4	1	1	2	1	1
CO5	1	2	2	1	2

Unit 1	Data Science Context	12 hours

Introduction: What is Data Science? Big Data and Data Science, Need for Data Science, Data Science Process – Business Intelligence and Data Science – Prerequisites for a Data Scientist – Tools and Skills required.
Matrices – Matrices to represent relations between data, and necessary linear algebraic operations on matrices -Approximately representing matrices by decompositions (SVD and PCA)

Unit 2	Databases for Data Science	12 hours

Structured Query Language (SQL): Basic Statistics, Filtering, Joins, Aggregation, Window Functions, Ordered Data, preparing No-SQL: Document Databases, Wide-column Databases and Graphical Databases

Unit 3	Data Science Methodology	12 hours

Data preprocessing: Data cleaning – data integration – Data Reduction Data Transformation and Data Discretization, Evaluation of classification methods – Confusion matrix,
Statistics: Descriptive Statistics: distributions and probability – Statistical Inference: Populations and samples – Statistical modeling – probability distributions – fitting a model – Hypothesis Testing

Unit 4	Platform for Data Science	12 hours

Python for Data Science –Python Libraries – Data Frame Manipulation with numpy and pandas – Exploration Data Analysis – Time Series Dataset – Clustering with Python – Dimensionality Reduction. Python integrated Development Environments (IDE) for Data Science.

Unit 5	Data Visualization	12 hours

Basic principles, ideas and tools for data visualization. Tableau Introduction – Dimensions, Measures, Descriptive Statistics, Basic Charts, Dashboard Design Principles, Special Chart Types, Integrate Tableau with Google Sheets.
Total Lecture hours **60 hours**
Textbook
1. Sanjeev Wagh, Manisha Bhende, Anuradha Thakare, 'Fundamentals of Data Science, CRC Press, 1st Edition, 2022. 2. Avrim Blum, John Hopcroft, Ravindran Kannan, "Foundations of Data Science", Cambridge University Press, First Edition, 2020. 3. Ani Adhikari and John DeNero, 'Computational and Inferential Thinking: The Foundations of Data Science', GitBook, 2019.
Reference Books 1. Mohammed J. Zaki and Wagner Miera Jr, "Data Mining and Analysis: Fundamental Concepts and Algorithms", Cambridge University Press, 2014. 2. Joel Grus, "Data Science from Scratch: First Principles with Python", O'Reilly Media, 1st Edition, 2015. 3. Wes McKinney, "Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython", O'Reilly Media, 2012.

Mode of Evaluation

MSE		CA			ESE	Total
MSE1	MSE2	CA1	CA2	CA3 (ATT)		
40	40	8	8	4		
80		20			100	200

Course Code: CS503L	Course Name : Advance DBMS	L	T	P	C
		4	0	0	4

Pre-requisite: Basic knowledge of database concepts, SQL, database design, and DBMS architecture.

Course Objectives

1. To develop a comprehensive understanding of distributed databases, including transaction management, concurrency control, and indexing techniques.
2. To equip students with the ability to apply advanced database concepts and disk management principles for problem solving in real-world scenarios.
3. To enable students to analyze and implement data mining, data warehousing, and web database applications using both SQL and NoSQL databases

Course Outcome : After completion of the course, the student will be able to

1. Understand distributed database transaction and concurrency mechanisms.
2. Apply indexing techniques and disk management principles.
3. Analyze advanced database concepts for problem-solving.
4. Analyze data mining and data warehouse techniques to extract meaningful patterns from large datasets.
5. Apply web database applications and effectively utilize SQL and NoSQL databases.

Co-PO Mapping (scale 1: low, 2: Medium, 3: High)

CO-PO Mapping	PO1	PO2	PO3	PSO1	PSO2
CO1	1	1	2	2	0
CO2	0	1	2	2	0
CO3	2	0	2	2	1
CO4	3	2	2	2	0
CO5	2	2	2	2	1

Unit 1	Relational Database Concepts and Distributed Database	12 hours
Relational Database Constraints, Normalization concepts, Denormalization, Transaction Processing introduction, Serializability concept. Distributed Database Concepts, Data Fragmentation, Replication and Allocation Techniques for Distributed Design, Types of Distributed Database Systems, Distributed Transaction Modeling and concurrency Control, Distributed Deadlock.		
Unit 2	**Disk Management and Indexing**	**12 hours**
Buffering of Blocks and Placing File Records on Disk, Operations on Files, Heap Files, Sorted Files, Hashing Techniques, Parallelizing Disk Access using RAID Technology, Secondary Access Paths, Types of Single-Level Ordered Indexes, Multilevel Indexes, Dynamic Multilevel Indexes Using B-Trees and B+ Trees.		
Unit 3	**Objected Oriented and Object Relational Databases**	**12 hours**
Introduction, Weakness of RDBMS, Object Oriented Concepts Storing Objects in Relational Databases, Next Generation Database Systems, Object Oriented Data models, OODBMS Perspectives, Persistence, Issues in OODBMS, Object Oriented Database Management System Manifesto, Advantages and Disadvantages of OODBMS, Object Oriented Database Design, OODBMS Standards and Systems, Object Management Group, Object Database Standard ODMG, Object Relational DBMS, Postgres, Comparison of ORDBMS and OODBMS.		
Unit 4	**Data Warehouse and Mining**	**12 hours**
Data warehousing concepts and architecture, data marts, Data Warehousing Lifecycle, dimensional modelling techniques, ETL (Extract, Transform, Load) processes, Data mining techniques, classification, clustering, OLAP (Online Analytical Processing) concepts, multidimensional data models, OLAP operations, and OLAP query, Emerging trends in data warehousing and business intelligence.		
Unit 5	**WEB Database and NoSQL databases**	**12 hours**
The Web as a Database Application Platform, Accessing Databases through WEB, WEB Servers, Scripting languages, Common Gateway Interface, Oracle Internet Platform, semi structured Data and XML, XML Related Technologies. Overview of NoSQL databases, Types of modeling, Benefits of NoSQL, comparison between SQL and NoSQL database system, NoSQL database management systems and tools.		
		Total Hours: 60 hrs

Textbook

1. Elmarsi, Navathe, Somayajulu, Gupta, "Fundamentals of Database Systems", 4th Edition, Pearson Education, 2007
2. Garcia, Ullman, Widom, "Database Systems, The complete book", Pearson Education, 2007
3. Silberscatz, Korth, Sudarshan, "Database System Concepts", Mcgraw Hill, 6th Edition, 2006.

Reference Books

1. Date, Kannan, Swaminathan, "An Introduction to Database Systems", 8th Edition Pearson Education, 2007
2. Singh S.K., "Database System Concepts, design and application", Pearson Education, 2006.
3. D. Maier, "The Theory of Relational Databases", Computer Science Press, Rokville, Maryland, 1993.
4. Subramanian V.S., "Principles of Multimedia Database Systems", Harcourt India Pvt Ltd., 2001.

Mode of Evaluation

MSE		CA			ESE	Total
MSE1	MSE2	CA1	CA2	CA3 (ATT)		
40	40	8	8	4		
80		20			100	200

Course Code: CS504L	Course Name : Advance Software Engineering	L	T	P	C
		3	0	0	3

Pre-requisite: Basics of software development and design.

Course Objectives

1. To provide a comprehensive understanding of software engineering principles, methodologies, and emerging trends, including applications of AI and ML.
2. To equip students with the skills to gather, analyze, and specify software requirements, as well as design robust software systems using best practices.
3. To develop effective software testing abilities and apply quality assurance metrics to ensure high-quality software delivery.

Course Outcome: After completion of the course, the student will be able to

1. Demonstrate an understanding of software engineering principles and various process models.
2. Gather and document software requirements using appropriate techniques.
3. Design software systems that meet specified requirements using design principles and models.
4. Perform software testing, apply debugging techniques, and utilize metrics for software quality.
5. Understand and apply AI and ML technologies in software engineering processes.

Co-PO Mapping (scale 1: low, 2: Medium, 3: High)

CO-PO Mapping	PO1	PO2	PO3	PSO1	PSO2
CO1	3	2	2	3	3
CO2	2	3	2	2	2
CO3	2	2	2	2	2
CO4	2	3	2	2	2
CO5	3	2	3	2	3

Unit 1	Introduction	9 hours

The evolving role of software, Changing Nature of Software, legacy software, Software myths. A Generic view of process: Software engineering - A layered technology, a process framework, The Capability Maturity Model Integration (CMMI), Process patterns, process assessment, personal and team process models. Process models: The waterfall model, Incremental process models, Evolutionary process models, Agile Process, Unified process.

Unit 2	Software Requirements and Design	9 hours

Functional and non-functional requirements, Requirement Gathering Techniques (Interviews, Surveys, Use Cases), software requirements document. Use Case Diagrams, Context Diagrams. Introduction to Software Design: Design Concepts: Abstraction, Modularity, Coupling, and Cohesion. Architectural Design and Design Patterns. Design Models:
Data Flow Diagrams (DFD), UML Diagrams (Class, Sequence, Activity).

Unit 3	Software Testing and Quality Assurance	9 hours

A strategic approach to software testing, test strategies for conventional software, Black-Box and White-Box testing, Validation testing, System testing, the art of Debugging. Product metrics: Software Quality, Framework for Product metrics, Metrics for Analysis Model, Metrics for Design Model, Metrics for source code, Metrics for testing, Metrics for maintenance. Metrics for Process and Products: Software Measurement, Metrics for software quality.

Unit 4	Software Maintenance and Configuration Management	9 hours

Software Maintenance: Types of Maintenance: Corrective, Adaptive, Perfective, Preventive. Maintenance Challenges and Techniques. Introduction to Version Control: What is version control and why it's important. Software Configuration

Management: Configuration Management planning, Change management, Version and release management, System building, CASE tools for configuration management.

Unit 5	Emerging Trends in Software Engineering	9 hours

Introduction to AI and ML in Software Engineering: Overview of Artificial Intelligence (AI) and Machine Learning (ML), How AI and ML are impacting software development and engineering, Differences between traditional software engineering and AI-driven development. AI and ML in Software Testing: Automated testing using AI and ML, How AI can help in creating test cases and identifying bugs. ML for Predictive Maintenance in Software. Ethical Considerations in Using AI in Software Engineering.

	Total Lecture hours	45 hours

Textbook

1. Roger S Pressman, Software Engineering: A Practitioners Approach, McGraw Hill, 9th ed. 2020.
2. Ian Sommerville, Software Engineering, seventh edition, Pearson education, 10th ed. 2015.

Reference Books

1. Rajib Mall, Fundamentals of Software Engineering, PHI Publication, 5th ed. 2018.
2. KK Aggarwal and Yogesh Singh, Software Engineering, New Age International Publishers, 4th ed. 2005.
3. Pankaj Jalote, "Software Project Management in Practice", Pearson, 2002
4. Stephen H Khan: Metrics and Models in Software Quality Engineering, Pearson, 2nd ed. 2013.
5. Derek Partridge, "Artificial Intelligence for Software Engineering" Springer, 1991.

Mode of Evaluation

MSE		CA			ESE	Total
MSE1	MSE2	CA1	CA2	CA3 (ATT)		
30	30	6	6	3		
60		15			75	150

Course Code: CS405L	Course Name : Research Methodology	L	T	P	C
		3	0	0	3

Pre-requisite: NA

Course Objectives

1. To foster a research-oriented mindset among scholars, encouraging independent applied research and critical thinking.
2. To develop a comprehensive understanding of the research process, enabling students to formulate effective research designs and articulate clear research questions.
3. To establish a strong foundation in descriptive and inferential statistics, equipping students with the analytical skills necessary for data interpretation and research analysis

Course Outcome : After completion of the course, the student will be able to

1. Define research problems, Prepare Research design and conduct literature survey.
2. Apply the concepts of probability and probability distributions.
3. Solve descriptive statistical analysis problems.
4. Contrast Test the hypothesis and check for statistical significance.
5. Apply various software and plagiarism tools and techniques for Research.

CO-PO Mapping (scale 1: low, 2: Medium, 3: High)

CO-PO Mapping	PO1	PO2	PO3	PSO1	PSO2
CO1	3	3	3	3	1
CO2	2	2	2	3	1
CO3	2	2	2	3	1
CO4	2	3	3	3	1
CO5	2	3	3	3	1

Unit 1	Research Design	9 hours

Developing a research plan, Research problem- selection and defining, Literature review, Research gaps, Research Designs- Elements, Need, Features and types, Developing Research Studies, Logical framework, methods to plan resources and validation of results.
Application Area: Identifying research area, formulating research problem, Literature review and design of research

Unit 2	Probability	9 hours

Concepts and axioms of probability; Bayes' Theorem, discrete and normal probability distribution, probability distribution functions and their applications, join distribution of two or more random variables, correlation coefficient, coefficient of variation.
Application Area: Basis for Hypothesis testing and validation

Unit 3	Descriptive Statistics	9 hours
Sampling, sampling distribution, Frequency Distribution, Measures of central tendency – mean, mode, median, measures of dispersion, measures of relationship, measures of skewness. **Application Area: Data collection, analysis and representation**		
Unit 4	**Inferential Statistics**	**9 hours**
Confidence Intervals, hypothesis testing, correlation, coefficient of determination, linear regression, parameter estimation using method of least squares, statistical test of significance, chi-square tests. **Application Area: Mathematical evaluation of the hypothesis and research**		
Unit 5	**Use of tools and techniques for Research**	**9 hours**
Methods to search required information effectively, Reference Management Software like Zotero/ Mendeley, Software for paper formatting like LaTeX/ MS Office, Software for detection of Plagiarism like Turnitin/Urkund. **Application Area: Effective research outcome/article writing and visibility**		
Total Lecture hours		**45 hours**

Textbook

1. Larsen, F. (n.d.). Elementary Statistics: Picturing the world, 5e, PrenticeHall (Vol. 5). PrenticeHall.
2. C. R. Kothari, Gaurav Garg, Research Methodology Methods and Techniques , New Age International publishers, Third Edition
3. Kreyszig, E. (1999). Advanced Engineering Mathematics 8e + Mathematica IBM 3.0 Set (Wse). John Wiley & Sons.

Reference Books

1. Vinay Kumar Srivastava. 2004. (ed) Methodology and Fieldwork, Oxford University Press, New Delhi
2. A Papoulis, " Probability, Random Variables and Stochastic Processes", McGraw Hill, 3rd Edt.,1991
3. Creswell, John W. Research design: Qualitative, quantitative, and mixed methods Approaches. Sage publications, 2013.
4. Ranjit Kumar, Research Methodology: A Step-by-Step Guide for Beginners, 2nd Edition, SAGE, 2005

Mode of Evaluation

MSE		CA			ESE	Total	
MSE1	MSE2	CA1	CA2	CA3 (ATT)			
30	30	6	6	3			
60		15			75	150	

Course Code : CS505B	Course Name: Advances in Data & Computer Communications	L	T	P	C
		4	0	2	5

Pre-requisite: Fundamentals of data communication and computer networks

Course Objectives

1. To provide a comprehensive understanding of digital communication systems and advanced networking concepts, including architecture, protocols, and standards.
2. To develop the ability to design, analyze, and optimize digital communication and network systems.
3. To equip students with the skills needed for research and innovation in communication and networking technologies.

Course Outcome : After completion of the course, the student will be able to

1. Understand and apply the principles of digital modulation and demodulation techniques.
2. Analyze the performance of communication systems in terms of bandwidth, power efficiency, and noise.
3. Evaluate the design and operation of networking protocols and architectures.
4. Utilize tools and software to simulate and model communication and networking systems.
5. Research emerging technologies and trends in digital communications and networking.

CO-PO Mapping (scale 1: low, 2: Medium, 3: High)

CO-PO Mapping	PO1	PO2	PO3	PSO1	PSO2
CO1	3	3	2	3	2
CO2	3	3	3	3	2
CO3	3	2	2	3	2
CO4	2	2	3	3	1
CO5	2	2	3	3	2

Unit 1	Introduction to Digital Communication	8 hours

Overview of Digital Communication: Evolution, advantages over analog communication, Elements of a Digital Communication System: Transmitter, Channel, Receiver, Digital Transmission: Signal conversion (Analog-to-Digital, Digital-to-Analog), Quantization, Source Encoding: Entropy, Shannon's theorem, Huffman coding, Lempel-Ziv coding, Line Coding Techniques: NRZ, RZ, Manchester coding, Differential encoding, Multiplexing: Time Division Multiplexing (TDM), Frequency Division Multiplexing (FDM), Code Division Multiplexing (CDM)

Unit 2	Modulation and Coding Techniques	8 hours

Introduction to Digital Modulation: Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), Phase Shift Keying (PSK), Quadrature Amplitude Modulation (QAM), Advanced Modulation Techniques: M-ary modulation, Quadrature Phase Shift Keying (QPSK), Orthogonal Frequency Division Multiplexing (OFDM), Error Detection and Correction: Parity checks, CRC, Hamming codes, Channel Capacity and Coding Theorems: Channel capacity, Shannon's limit, Forward Error Correction (FEC).

Unit 3	Data Transmission Fundamentals	24 hours

Overview of Data Communication Systems: Layers of communication protocols, Network Models: OSI and TCP/IP models, protocol layering, Data Link Layer: Error control, flow control, Medium Access Control (MAC) protocols (ALOHA, CSMA/CD, CSMA/CA), Multiplexing in Networks: Wavelength Division Multiplexing (WDM), Dense WDM (DWDM), Optical networks, Switching Techniques: Circuit switching, packet switching, hybrid switching, Network Hardware: Hubs, switches, routers, gateways.

Hands-on:

- Demonstration of networking devices on Cisco Packet Tracer
- Network simulation using Networking Tools
- Examining WAN Connections

Unit 4	Advanced Concepts and Protocols	25 hours

Network Layer: IP addressing (IPv4/IPv6), subnetting, VLSM, routing algorithms (RIP, OSPF, BGP), Transport Layer: Transport protocols (TCP, UDP), flow control, congestion control mechanisms, Congestion Control Algorithms: TCP congestion control, Quality of Service (QoS): QoS requirements, MPLS, Virtual Private Networks (VPNs): Types, security protocols (IPSec, SSL/TLS), Wireless Networks: Wi-Fi (802.11), Cellular networks (3G, 4G, 5G), MANETs.

Hands-on:

- Network packet analysis using tools like Wireshark, tcpdump etc.
- Implement Static and Default routing using RIP protocol
- Routing protocols for mobile ADHOC networks
- Comparison of UDP and TCP performance in high latency networks
- Configuring WEP on a Wireless Router
- Demonstrate wired and wireless network on Cisco Packet Tracer

Unit 5	Emerging Trends	25 hours

Next Generation Networks (NGN): Convergence of networks, VoIP, Softswitch, 5G Communications: Architecture, frequency spectrum, key technologies (MIMO, mmWave), Software-Defined Networking (SDN): Architecture, OpenFlow, network virtualization, Network Function Virtualization (NFV): Principles, NFV infrastructure, service chaining, Internet of Things (IoT): Communication protocols (MQTT, CoAP), sensor networks, IoT applications, Network Security: Firewalls, intrusion detection systems, encryption techniques, Blockchain in Communication Networks:
Decentralization in communication, secure data transmission.

Hands-on: Planning Network-based Firewalls

Total Lecture hours	**90 hours**

Textbook

1. John G. Proakis, Masoud Salehi, *Digital Communications*, McGraw Hill, 5th Edition, 2007.
2. Behrouz A. Forouzan, *Data Communications and Networking*, McGraw-Hill Education, 5th Edition, 2012.

Reference Books

1. Simon Haykin, *Communication Systems*, Wiley, 5th Edition, 2009.
2. A. Tanenbaum, *Computer Networks*, Pearson Education, 5th Edition, 2011

Mode of Evaluation

MSE		CA			ESE	Total
MSE1	MSE2	CA1	CA2	CA3 (ATT)		
50	50	10	10	5		
100		25			125	250

Course Code : AI501B	Course Name :Machine Learning	L	T	P	C
		4	0	2	5

Pre-requisite: NA

Course Objectives

1. To provide a comprehensive understanding of the foundational concepts in machine learning
2. To develop proficiency in applying both supervised and unsupervised learning algorithms.
3. Gain expertise in advance machine learning techniques.

Course Outcome : After completion of the course, the student will be able to

1. Understand the fundamental concepts of machine learning and its applications.
2. Apply linear regression, logistic regression, and support vector machines for supervised learning tasks.
3. Apply clustering algorithms such as K-means, hierarchical clustering, and density-based clustering.
4. Implement recurrent neural networks (RNNs) for sequence modeling in natural language processing and time series analysis.
5. Apply Bayesian learning techniques and probabilistic graphical models for modeling uncertainty.

CO-PO Mapping (scale 1: low, 2: Medium, 3: High)

CO / PO	PO1	PO2	PO3	PSO1	PSO2
CO1	3	2	3	3	2
CO2	3	2	3	3	2
CO3	3	2	3	3	2
CO4	3	2	3	3	2
CO5	3	2	3	3	2

Unit 1	Foundations of Machine Learning	10 hours

Introduction to machine learning: definition, types, and applications, Probability and statistics for machine learning, Linear algebra for machine learning, Data preprocessing and feature engineering

Unit 2	Supervised Learning	15 hours

Linear regression: Simple linear regression, Multiple linear regression, Polynomial regression, logistic regression: Binary logistic regression, Multiclass logistic regression, Regularized logistic regression (L1 and L2 regularization), Support Vector Machines (SVM), Decision trees and ensemble methods (e.g., random forests, gradient boosting), Evaluation metrics and model selection.

Hands on:

- Implementing linear regression from scratch using Python
- Building a logistic regression classifier for binary classification
- Developing a multiclass logistic regression model for image classification
- Creating a support vector machine (SVM) classifier for text categorization
- Building decision trees and random forests for predicting customer churn

Unit 3	Unsupervised Learning and Dimensionality Reduction	20 hours

Clustering algorithms: K-means clustering, Hierarchical clustering (agglomerative and divisive), Density-based clustering (e.g., DBSCAN), Evaluation metrics for clustering (e.g., Silhouette coefficient), Dimensionality reduction techniques: Principal Component Analysis (PCA), Singular Value Decomposition (SVD), t-Distributed Stochastic Neighbor Embedding (t-SNE), Non-negative Matrix Factorization (NMF), Association rule learning: Apriori algorithm, Association metrics (e.g., support, confidence, lift), Market basket analysis and frequent itemsets, anomaly detection.
Hands-on:

- Implementing k-means clustering for customer segmentation
- Building a hierarchical clustering algorithm for image clustering
- Developing a density-based clustering algorithm (DBSCAN) for anomaly detection
- Implementing principal component analysis (PCA) for dimensionality reduction
- Applying singular value decomposition (SVD) for image compression
- Building a recommendation system using collaborative filtering
- Implementing the Apriori algorithm for market basket analysis

Unit 4	Deep Learning and Neural Networks	22 hours

Fundamentals of neural networks: Neurons and activation functions, Feedforward neural networks, Backpropagation algorithm, Gradient descent optimization, Convolutional Neural Networks (CNN): Convolutional layers and filters, Pooling layers, CNN architectures (e.g., LeNet-5, VGGNet, ResNet), Transfer learning with pre-trained CNNs, Recurrent Neural Networks (RNN): Basic RNN architecture, Long Short-Term Memory (LSTM) and Gated Recurrent Unit (GRU), Sequence-to-sequence models, Applications of RNNs in natural language processing and time series analysis for sequence modeling. Hands-on:

- Building a time series forecasting model using recurrent neural networks (RNNs)
- Implementing a convolutional neural network (CNN) for image recognition
- Developing a recurrent neural network (RNN) for text generation
- Creating a text summarization model using sequence-to-sequence (Seq2Seq) architecture
- Implementing an autoencoder for unsupervised feature learning

Unit 5	Advanced Topics in Machine Learning	23 hours

Reinforcement learning and Markov Decision Processes (MDP), Bayesian learning and probabilistic graphical models, Natural Language Processing (NLP) and sentiment analysis, Ethical considerations in machine learning.
Hand-on:

- Creating a sentiment analysis model using natural language processing (NLP)
- Implementing Q-Learning for a simple reinforcement learning task
- Developing a generative adversarial network (GAN) for image synthesis
- Building a deep reinforcement learning model for playing games
- Implementing Bayesian networks for probabilistic reasoning
- Developing a hidden Markov model (HMM) for speech recognition
- Implementing an autoencoder for unsupervised feature learning
- Developing a deep learning model for sentiment analysis in social media data

	Total hours	90 hours

Textbook

1. "Pattern Recognition and Machine Learning" by Christopher Bishop
2. "Machine Learning: A Probabilistic Perspective" by Kevin P. Murphy
3. "Deep Learning" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville
4. "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow" by Aurélien Géron
5. "The Elements of Statistical Learning" by Trevor Hastie, Robert Tibshirani, and Jerome Friedman

Reference Books

1. Kevin Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012
2. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning, Springer 2009 (freely available online)
3. Christopher Bishop, Pattern Recognition and Machine Learning, Springer, 2007

Mode of Evaluation

MSE		CA			ESE	Total
MSE1	MSE2	CA1	CA2	CA3 (ATT)		
50	50	10	10	5		
100		25			125	250

Course Code: CS506L	Course Name : Scientific Writing, Ethics and IPR	L	T	P	C
		3	0	0	3

Pre-requisite: NA

Course Objectives

1. To cultivate effective scientific writing skills, enabling students to communicate their research findings clearly and concisely.
2. To foster a strong understanding of ethical standards in research and publication, promoting integrity and accountability among scholars.
3. To provide a comprehensive overview of intellectual property rights, equipping students with the knowledge to navigate the complexities of patents, copyrights, and research commercialization.

Course Outcome : After completion of the course, the student will be able to

1. Formulate research questions and develop structured research proposals in line with scientific writing standards.
2. Analyze and apply various citation styles and referencing tools to enhance research documentation.
3. Identify and address ethical issues related to publication, including plagiarism and authorship disputes.
4. Evaluate and select appropriate journals for research dissemination, considering factors such as impact factor and indexing.
5. Understand and explain the significance of intellectual property rights in research, including patent application processes and technology transfer.

CO-PO Mapping (scale 1: low, 2: Medium, 3: High)

CO / PO	PO1	PO2	PO3	PSO1	PSO2
CO1	3	3	3	1	1
CO2	3	2	3	1	1
CO3	3	2	3	1	1
CO4	3	2	3	1	1
CO5	1	1	3	1	1

Unit 1	Basics of Scientific Writing	9 hours

Introduction to scientific writing, Types of research: Basic, applied, experimental, Research problem formulation, identifying research gaps, framing appropriate research questions, objectives, and hypotheses. Structure of a research paper: Title, abstract, introduction, methods, results, discussion, and references, Clarity and precision in scientific writing, Writing effective abstracts, introductions and literature review.

Unit 2	Advanced Writing	9 hours

Citation and referencing styles (APA, IEEE), Reference management tools: Mendeley, EndNote, Citation databases: Web of Science, Scopus, etc., Research Metrics: Impact Factor of journal as per journal citation report, SNIP, SJR, IPP, Cite Score. Metrics: h-index, g index, i10 index, Google Scholar, Research Gate, Pub-med etc.

Unit 3	Publication Ethics	9 hours

Publication ethics: definition, introduction and importance, plagiarism, Best practices/standards setting initiatives and guidelines: COPE, WAME, etc., Conflicts of interest, Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa, types, Violation of publication ethics, authorship and contributor-ship, Identification of publication misconduct, complaints and appeals, Predatory publishers and journals; Approved and peer reviewed Research journals.		
Unit 4	**Intellectual Property Rights**	**9 hours**
Nature of Intellectual Property: Patents, Designs, Trade Mark and Copyright. Process of Patenting and Development: technological research, innovation, patenting & development. Procedure for grants of patents, Patenting under PCT.		
Unit 5	**Patent Rights and New Developments in IPR**	**9 hours**
Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System.		
	Total Lecture hours	**45 hours**

Textbook

1. Day, R. A., & Gastel, B. (2012). How to Write and Publish a Scientific Paper (7th ed.). Cambridge University Press.
2. Kothari, C. R. (2004). Research Methodology: Methods and Techniques (2nd ed.). New Age International Publishers.
3. T. Ramappa (2008). Intellectual Property Rights Under WTO", S. Chand.

Reference Books

1. Booth, W. C., Colomb, G. G., & Williams, J. M. (2008). The Craft of Research (3rd ed.). University of Chicago Press.
2. Singh, Y. K. (2006). Research Methodology: Techniques and Trends. New Age International Publishers.
3. Deborah E. Bouchoux, Intellectual Property: The Law of Trademarks, Copyrights, Patents, and Trade Secrets, Delmar Cengage Learning
4. Panda, T. K. (2018). IPR for Management. PHI Learning.
5. Robert P. Merges, Peter S. Menell and Mark A. Lemley. (2016). Intellectual Property in New Technological Age", Aspen Publishers, 2016.

Mode of Evaluation

MSE		CA			ESE	Total	
MSE1 30	MSE2 30	CA1 6	CA2 6	CA3 (ATT) 3			
60		15			75	150	

Course Code : CS507E	Course Name : Natural Language Processing	L	T	P	C
		4	0	0	4

Pre-requisite: NA

Course Objectives

1. To understand fundamental concepts and applications of Natural Language Processing, particularly in Indian languages.
2. To develop skills in morphological analysis and Machine Translation techniques for addressing NLP challenges.
3. To explore advanced NLP applications like sentiment analysis and speech recognition for real-world implementation.

Course Outcome: After completion of the course, the student will be able to

1. Understand the concept of Natural Language Processing (NLP), its challenges and applications.
2. Process words and word forms of the language by considering its morphology, paradigms and named entities.
3. Demonstrate the use of machine translation by using rule-based MT, Knowledge Based MT, and Statistical Machine Translation etc.
4. Understand the concepts of WorldNet, Semantic Roles, and Word Sense Disambiguation.
5. Demonstrate the use of NLP in speech recognition and other emerging applications like Sentiment Analysis, Information Retrieval etc.

Co-PO Mapping (scale 1: low, 2: Medium, 3: High)

CO / PO	PO1	PO2	PO3	PSO1	PSO2
CO1	3	2	3	2	1
CO2	3	2	2	2	1
CO3	3	2	3	3	1
CO4	2	2	2	2	2
CO5	3	2	3	3	2

Unit 1	**Introduction**	**12 hours**
Origin of Natural Language Processing (NLP), Challenges of NLP, NLP Applications, Processing Indian Languages. Grammar-based LM, Statistical LM.		
Unit 2	**Words and Word Forms**	**12 hours**
Morphology fundamentals; Morphological Diversity of Indian Languages; Morphology Paradigms; Finite State Machine Based Morphology; Automatic Morphology Learning; Shallow Parsing; Named Entities; Maximum Entropy Models; Random Fields, Scope Ambiguity and Attachment Ambiguity resolution.		
Unit 3	**Machine Translation**	**12 hours**
Need of MT, Problems of Machine Translation, MT Approaches, Direct Machine Translations, Rule-Based Machine Translation, Knowledge Based MT System, Statistical Machine Translation, UNL Based Machine Translation, Translation involving Indian Languages.		
Unit 4	**Meaning**	**12 hours**
Lexical Knowledge Networks, WorldNet Theory; Indian Language Word Nets and Multilingual Dictionaries; Semantic Roles; Word Sense Disambiguation; WSD and Multilinguality; Metaphors.		
Unit 5	**Speech Recognition**	**12 hours**
Signal processing and analysis method, Articulation and acoustics, Phonology and phonetic transcription, Word Boundary Detection; Argmax based computations; HMM and Speech Recognition. Other Applications: Sentiment Analysis; Text Entailment; Question Answering in Multilingual Setting; NLP in Information Retrieval, Cross-Lingual IR.		
	Total Lecture hours	**60 hours**

Textbook

1. Siddiqui and Tiwary U.S., Natural Language Processing and Information Retrieval, Oxford University Press (2008).
2. Allen J., Natural Language understanding, Benjamin/Cunnings, (1987).
3. Jensen K., Heidorn G.E., Richardson S.D., Natural Language Processing: The PLNLP Approach, Springer (2013).
4. Roach P., Phonetics, Oxford University Press (2012).

Reference Books

1. Lawrence Rabiner and Biing-Hwang Juang, "Fundamentals of Speech Recognition", Pearson Education, 2003.
2. Daniel Jurafsky and James H Martin, "Speech and Language Processing – An Introduction To Natural Language Processing, Computational Linguistics, And Speech Recognition", Pearson Education, 2002. 3.Breck Baldwin, —Language Processing with Java and LingPipe Cookbook, Atlantic Publisher, 2015

MSE		CA			ESE	Total	
MSE1 40	MSE2 40	CA1 8	CA2 8	CA3(ATT) 4			
80		20			100	200	

Course Code : CS512E	Course Name : Advanced Java Programming	L	T	P	C
		4	0	0	4

Pre-requisite: Basic knowledge of object-oriented concepts

Course Objectives

1. To gain a comprehensive understanding of J2EE, including MVC architecture, GUI components, and event handling.
2. To learn networking concepts and their importance in ensuring security within distributed systems
3. To develop dynamic web applications using JSP and Servlets, and deploy them on servers like Tomcat, while also exploring advanced Java frameworks for hardware interaction.

Course Outcome : After completion of the course, the student will be able to

1. Use advanced java techniques to make the front end of real time applications
2. Examine the concepts of networking and its authentications.
3. Apply the distributed, RMI concepts and to further integrate the web apps through database.
4. Demonstrate the enterprise applications using Servlets and JSP.
5. Utilize the advanced frameworks like Spring, JWT and JMF.

Co-PO Mapping (scale 1: low, 2: Medium, 3: High)

CO-PO Mapping	PO1	PO2	PO3	PSO1	PSO2
CO1	3	2	3	3	1
CO2	3	2	2	2	1
CO3	3	2	3	3	2
CO4	3	3	3	3	2
CO5	3	2	3	3	2

Unit 1	J2EE Basics and GUI Components	12 hours

Java-Web Basics: Introduction to Java, J2EE architecture, HTTP protocol, Web application, Web containers and Application servers

Swing: Introduction, MVC Architecture, Component, container, window, frame, panel, applets, Swing components. **Event handling:** The delegation Event Model, Event sources, Event listeners, Event classes, Event listener interfaces.

JavaFx: Introduction, History, Features, JavaFX Architecture, Application Structure, Creating first JavaFX Application 2D Shapes, 3D Shapes, Effects, Animation, Text, Layouts, UI Controls, Charts, JavaFX with Media, Event Handling

Unit 2	Networking and Security Concepts	9 hours

Networking: Connecting to a Server, Implementing Servers, Sending E-Mail , making URL Connections, Advance Socket programming.

Security: Class Loaders, Security Manager and Permissions, User Authentication Digital Signatures, Code Signing JAR file Signing, Encryption.

Internationalization: Locales Number formats, Message Formatting, Text files and Character Sets, Resources Bundles Classes, Native Methods.

Unit 3	Managing Large Scale Enterprise Level Application	12 hours

EJB: Introduction to java bean and EJB, creating and accessing a JavaBean class, JavaBean Properties.
EJB Container: Jboss, Glassfish, Weblogic, Websphere etc. Types of EJB: Session Bean, Message Driven Bean, Entity Bean.

Remote Method Invocation: Introduction, Comparison of Distributed and Non-distributed Java programs, RMI Packages, RMI Enhancements, RMI and EJB

JDBC: Introduction, Drivers, DB connectivity steps.
Interface: Statement interface, ResultSet interface, PreparedStatement interface, ResultSetMetaData interface, CallableStatement Interface.
CRUD operations, Transaction Management.

Unit 4	Developing Web Applications with Servlet and JSP	12 hours

Servlet: Fundamentals , A simple Servlet, Servlet API; Servlet vs. CGI , Life Cycle, Javax.servlet Package, Javax.servlet.http package, Handling HTTP Requests and Responses, HTTP GET and POST, Processing Html Forms, Content Types and MIME, Web-Container, web.xml, URL Pattern Mapping , HTTP Session, Cookies
Java Server Pages (JSP): Introduction, Life cycle, Scripting elements: scriptlet tag, expression tag, declaration tag, Implicit Objects: JSP Request, JSP Response, JSP Config, JSP Application, JSP Session, JSP PageContext, JSP Page, JSP Exception, JSP Directive Elements: JSP page directive, JSP include directive, JSP taglib directive, Action Elements, Java Bean class, jsp:useBean, setProperty & getProperty, MVC in JSP, JSP Custom Tag Library

Unit 5	**Java Frameworks**	**12 hours**

Spring Framework: Introduction, Benefits, Applications, Core Features, Architecture, Environment Setup, Steps of developing a Spring project, Spring- JDBC, Transaction Management.
Google Web Toolkit (GWT): Introduction, Components of GWT, modes, Create simple web development project, Deployment Descriptor, Running GWT Web Application, GWT Layout Panels: GWT Root Layout Panel, GWT Dock Layout Panel, GWT Split Layout Panel, GWT Stack Layout Panel.
Java Media Framework(JMF): Introduction, Features, Model, Architecture, Installing JMF, JMStudio, Media transmission and reception using JMStudio, First program in the JMF to play an audio file, MediaPlayer, uses the JMF to load and display a movie or audio file from a specified URL.

Total Lecture hours	**60 hours**

Textbook

1. Java The Complete Reference 9th edition, Herbert Schildt, Mc Graw Hill Education, 2014.
2. Programming with Java, E. Balagurusamy.
3. Java 2 Programming Black Book Holzner, Steven et al. Dreamtech Press, New Delhi ISBN 10: 817722655X/ ISBN 13: 9788177226553
4. Java Server Programming Tutorial JAVA EE6 Black Book Kogent Learning Solutions Dreamtech Press, New Delhi ISBN :978-81-7722-937-0
5. Spring Boot in Action First Edition by Craig Walls

Mode of Evaluation

MSE		CA			ESE	Total	
MSE1 40	MSE2 40	CA1 8	CA2 8	CA3 (ATT) 4			
80		20			100	200	

Course Code : CS517E	**Course Name : Blockchain Technology**	**L**	**T**	**P**	**C**
		4	**0**	**0**	**4**

Pre-requisite: NA

Course Objectives

1. The course aims to provide a strong foundation on the principles and workings of blockchain technology, including the history, types, characteristics, and advantages of blockchain.
2. Develop a clear understanding of the cryptographic techniques used in blockchain technology, the architecture of blockchain and the consensus mechanisms used in the blockchain.
3. Acquire practical knowledge of writing, deploying, and interacting with smart contracts and application of the blockchain.

Course Outcome : After completion of the course, the student will be able to

1. Identify the main components of blockchain architecture, including transaction models, data structure, and network protocols.
2. Describe the process and importance of consensus mechanisms, such as Proof of Work, Proof of Stake, and Delegated Proof of Stake.
3. Use the fundamental principles of blockchain technology to design and implement basic blockchain applications.
4. Analyze the functionality of different blockchain platforms such as Bitcoin, Ethereum, and Hyperledger Fabric.
5. Evaluate emerging trends in blockchain technology such as Decentralized Finance (DeFi) and scalability solutions and predict potential future developments.

Co-PO Mapping (scale 1: low, 2: Medium, 3: High)

CO-PO Mapping	PO1	PO2	PO3	PSO1	PSO2
CO1	3	2	3	2	1
CO2	3	2	2	2	1
CO3	3	3	3	3	2
CO4	3	2	3	2	2
CO5	2	2	2	2	3

Unit 1	**Blockchain basics**	**12 hours**

Overview of Blockchain, Public Ledgers, Bitcoin, Smart Contracts, Block in a Blockchain, Transactions, Distributed Consensus, Public vs Private Blockchain, Understanding Crypto currency to Blockchain, Permissioned Model of Blockchain, Cryptographic Hash Function, Properties of a hash function, Hash pointer and Merkle tree, Digital Signature, Public Key Cryptography, A basic cryptocurrency, Generation of keys, Digital signatures, Zero-knowledge systems.

Unit 2	**Consensus Mechanism**	**12 hours**

Distributed consensus in open environments, Consensus in a Bitcoin network, Proof of Work (PoW): basic introduction, Hashcash PoW, Bitcoin PoW, Attacks on PoW and the monopoly problem, Proof of Stake, Proof of Burn and Proof of Elapsed Time, The life of a Bitcoin Miner, Mining Difficulty, Mining Pool, Mining in Blockchain, Steps in Mining, Double spending, Consensus protocols, PoW, Hashcash, Attacks on Bitcoin, Sybil Attacks, 51% Attack, eclipse attacks, DDoS Attacks, Replay Attacks, Byzantine fault, node failure.

Unit 3	**Smart Contracts**	**12 hours**

Blockchain types-Public Blockchain, Private Blockchain, Federated Blockchain, Permissionless, Permissioned Blockchain Networks, Ethereum blockchain, Go Ethereum, Gas, Gas price, Gas Limit, ETH, MetaMask, Public Test Networks, Smart contracts in Blockchain, Solidity, Data types in solidity, Operators, State variables, Global Variables, Local variables.

Unit 4	**Hyperledger Fabric**	**12 hours**

Permissioned Blockchain Architecture, Identities and Policies, Membership and Access Control, Channels, Decomposing the consensus process, Hyperledger fabric components, Chaincode Design, and Implementation, Transaction Validation, writing smart contract using Hyperledger Fabric, Overview of Ripple and Corda.

Unit 5	**Applications of Blockchain Technology**	**12 hours**

Cross border payments, Know Your Customer (KYC), Food Security, Mortgage over Blockchain, Blockchain enabled Trade, We Trade — Trade Finance Network, Supply Chain Financing, Identity on Blockchain.

	Total Lecture hours	**60 hours**

Textbook

1. Andreas Antonopoulos, “Mastering Bitcoin: Unlocking Digital Cryptocurrencies”, O’Reilly, 2014.
2. Melanie Swan, “Blockchain: Blueprint for a New Economy”, O’Reilly, 2015.
3. Bettina Warburg, Bill Wanger and Tom Serres, Basics of Blockchain (1 ed.), Independently published, 2019. ISBN 978-1089919445.
4. Holbrook and Joseph, Architecting enterprise blockchain solutions (1 ed.), John Wiley & Sons, 2020. ISBN 978- 00000000.

5. Bashir and Imran, Mastering blockchain: "Distributed ledger technology, decentralization, and smart contracts explained (1 ed.), Packt Publishing Ltd, 2018. ISBN 978- 11111111.

Reference Books

1. Iran Bashir "Mastering Blockchain", Second Edition Paperback, 2018.
2. Daniel Drescher, "Blockchain Basics", First Edition, Apress, 2017.
3. Ritesh Modi, "Solidity Programming Essentials: A Beginner's Guide to Build Smart Contracts for Ethereum and Blockchain", Packt Publishing.

Mode of Evaluation

MSE		CA			ESE	Total	
MSE1 40	MSE2 40	CA1 8	CA2 8	CA3 (ATT) 4			
80		20			100	200	

Course Code : CS508E	Course Name : Advance Statistical Methods	L	T	P	C
		3	0	0	3

Pre-requisite: Basic statistics and probability theory

Course Objectives

1. To provide in-depth knowledge of statistical theories and methodologies for analyzing complex data using advanced statistical tools.
2. To provide hands-on experience with statistical software and programming languages like python, fostering the ability to implement computational methods
3. To apply multivariate techniques, regression models, and advanced statistical methods to solve interdisciplinary problems.

Course Outcome : After completion of the course, the student will be able to

1. Analyze and interpret advanced probability distributions, statistical inferences, and Bayesian approaches for complex data-driven problems.
2. Apply regression models, generalized linear models, and multivariate statistical techniques to address real-world scenarios.
3. Apply statistical methodologies to solve problems involving time series and survival analysis.
4. Implement statistical models to visualize data using Python language.
5. Interpret statistical findings enabling data-driven decision-making in research, industry, and other professional contexts.

CO-PO Mapping (scale 1: low, 2: Medium, 3: High)

CO-PO Mapping	PO1	PO2	PO3	PSO1	PSO2
CO1	3	2	3	3	-
CO2	3	2	3	3	-
CO3	3	1	3	3	-
CO4	2	2	3	3	-
CO5	3	3	3	2	2

Unit 1	Foundations of Statistical Theory	9 hours

Probability Distributions: Review of Probability Concepts, Normal, Binomial, Poisson, Exponential, and Multivariate Distributions, Central Limit Theorem and its Applications, Principles of Estimation: Point Estimation and Interval Estimation, Hypothesis Testing: Concepts, Types of Errors, p-values, and Power, Bayesian Statistics: Bayes' Theorem in Decision Making, Prior, Likelihood, and Posterior Distributions, Applications of Bayesian Inference

Unit 2	Regression and Modelling Techniques	9 hours

Linear Models: Simple and Multiple Linear Regression, Assumptions of Linear Models and Diagnostics, Least Squares Estimation and Interpretation of Coefficients, Generalized Linear Models (GLMs): Logistic Regression, Poisson Regression, Model Selection and AIC/BIC		
Unit 3	**Multivariate Statistical Methods**	**9 hours**
Multivariate Data Analysis: Multivariate Normal Distribution, Principal Component Analysis (PCA), Classification and Clustering: Discriminant Analysis (LDA, QDA), Hierarchical and k-Means Clustering, Introduction to Advanced Methods (DBSCAN, Gaussian Mixture Models)		
Unit 4	**Advanced Topics in Statistical Methods**	**9 hours**
Time Series Analysis: Stationarity and ARIMA Models, Seasonal Decomposition, Forecasting Techniques, Survival Analysis: Survival and Hazard Functions, Kaplan-Meier Estimator, Cox Proportional Hazards Model		
Unit 5	**Computational Statistics and Applications**	**9 hours**
Statistical Computing with Python: Data Manipulation and Visualization, Implementing Statistical Methods, Simulation Techniques, Monte Carlo Methods: Importance Sampling, Markov Chain Monte Carlo (MCMC), Gibbs Sampling and Metropolis-Hastings Algorithm, Applications in Real-World Problems: Case Studies in Medicine, Engineering, and Social Sciences, Data-Driven Decision Making, Reporting and Communicating Statistical Findings		
	Total Lecture hours	**45 hours**

Textbooks

1. Montgomery, D. C., & Runger, G. C. *Applied Statistics and Probability for Engineers*, John Wiley & Sons, 7th Edition, 2018.
2. Box, G. E., Jenkins, G. M., & Reinsel, G. C. *Time Series Analysis: Forecasting and Control,* John Wiley & Sons, 5th Edition, 2015.
3. James, G., Witten, D., Hastie, T., & Tibshirani, R. *An Introduction to Statistical Learning,* 2nd Edition, Springer, 2021.

Reference Books

1. Dennis Wackerly, William Mendenhall, and Richard L. Scheaffer. *Mathematical Statistics with Applications,* Cengage Learning, 7th Edition 2007.
2. Trevor Hastie, Robert Tibshirani, and Jerome Friedman. *The Elements of Statistical Learning: Data Mining, Inference, and Prediction,* Springer, 2009

Mode of Evaluation

MSE		CA			ESE	Total
MSE1 30	MSE2 30	CA1 6	CA2 6	CA3 (ATT) 3		
60		15			75	150

Course Code : CS513E	Course Name : DevOps	L	T	P	C
		3	0	0	3

Pre-requisite: NA

Course Objectives

1. Provide an overview of the DevOps philosophy, its evolution, and the benefits it offers to organizations.
2. Learn about the fundamentals of cloud computing and how it aligns with DevOps practices using AWS platform.
3. Understand the principles and techniques of continuous delivery and continuous deployment.

Course Outcome : After completion of the course, the student will be able to

1. To provide a comprehensive understanding of the core principles and concepts of Cloud and DevOps.
2. To understand and implement the automation tools in for of scripting language using linux OS and version control system.
3. To analyze virtualization in AWS cloud computing environment.
4. To apply DevOps practices in real-world scenarios by setting up and managing CI/CD pipelines, automating infrastructure provisioning and configuration in SDLC.
5. To design the microservices infrastructure and resolve the issues that may arise during the software development and deployment processes.

CO-PO Mapping (scale 1: low, 2: Medium, 3: High)

CO / PO	PO1	PO2	PO3	PSO1	PSO2
CO1	2	2	2	2	3
CO2	2	2	3	2	3
CO3	2	2	3	2	3
CO4	1	2	3	2	3
CO5	2	2	3	2	3

Unit 1	**Introduction to DevOps**	**9 hours**

DevOps: Introduction to DevOps, History, SDLC Models: Waterfall and Agile.
Cloud Fundamentals: Introduction to cloud, Cloud Models, IAAS, PAAS, SAAS, Hypervisor, Virtualization.
Network Fundamentals: OSI Model, Network Topology, IP Addressing, Protocols and Ports, Routing and Firewall.
Storage Fundamentals: File Storage, SAN, NAS.
Web Servers: Apache, NGINX, IIS, Load Balancer.

Unit 2	**Linux Operating System**	**9 hours**

Linux OS Introduction, Linux Basic Command Utilities, Linux Basic Command Utilities, Linux Administration, Environment Variables, Networking, Linux Server Installation, Storage management, Server Configuration.
Shell Scripting: Introduction, Variables, Flow Controls, Loops, Functions, Lists, Manipulating Strings, Cron.
Version Control-GIT: GIT – Clone /Commit / Push, GIT Rebase & Merge, GIT Stash, Reset, Checkout, GIT Clone, Fetch, Pull.

Unit 3	**Amazon Web Services**	**9 hours**

AWS Fundamentals, IAM, EC2, VPC, S3, Cloud Watch, Route-53, RDS, DynamoDB, Aurora, Load Balancer, Serverless Architecture-AWS Lambda
Build Tool: Maven, Maven Installation, Maven Build requirements, Maven POM Builds (pom.xml)

Unit 4	**Continuous Integration**	**9 hours**

Jenkins: Introduction to Jenkins, Continuous Integration with Jenkins, Configure Jenkins, Jenkins Management, Scheduling build Jobs, Support for the GIT version control System, Different types of Jenkins Jobs, Jenkins Build Pipe Line, Jenkins Plugins- Installing Jenkins Plugins, SCM plugin, Build and test.
Ansible: Introduction to Ansible, Ansible Server Configuration, Infrastructure Management, SSH Connection in Ansible Master, YAML Scripts, Playbooks, Ansible Roles

Unit 5	**Docker & Kubernetes**	**9 hours**

Introduction to Docker, Docker Image, Docker Installation, Docker Containers- What is Container, Docker Engine, Creating Containers with an Image, working with Images, Docker Compose, Docker Hub, Docker File and commands.
Kubernetes- Introduction to Kubernetes and Architecture, Replicaset and Deployment.

	Total Lecture hours	**45 hours**

Textbook

1. "The Phoenix Project: A Novel About IT, DevOps, and Helping Your Business Win" by Gene Kim, Kevin Behr, and George Spafford (First Edition, 2013, IT Revolution Press)
2. "The DevOps Handbook: How to Create World-Class Agility, Reliability, and Security in Technology Organizations" by Gene Kim, Patrick Debois, John Willis, and Jez Humble (First Edition, 2016, IT Revolution Press)
3. "Continuous Delivery: Reliable Software Releases through Build, Test, and Deployment Automation" by Jez Humble and David Farley (First Edition, 2010, Addison-Wesley Professional)
4. "DevOps for the Modern Enterprise: Winning Practices to Transform Legacy IT Organizations" by Mirco Hering (First Edition, 2018, IT Revolution Press)

Reference Books

1. "Effective DevOps: Building a Culture of Collaboration, Affinity, and Tooling at Scale" by Jennifer Davis and Katherine Daniels (2016, O'Reilly Media)
2. "The Art of Monitoring" by James Turnbull (2014, James Turnbull Pty. Ltd.)
3. "Docker Deep Dive" by Nigel Poulton (2019, Nigel Poulton)

Mode of Evaluation

MSE		CA			ESE	Total	
MSE1	MSE2	CA1	CA2	CA3 (ATT)			
30	30	6	6	3			
60		15			75	150	

Course Code: CS516E	Course Name : Quantum Computing	L	T	P	C
		3	0	0	3

Pre-requisite: NA

Course Objectives

1. To analyze the behavior of basic quantum environment & algorithms.
2. To explore different machine learning algorithms implementation in different engineering contexts.
3. To investigate optimization problem in quantum computing.

Course Outcome

1. Understand the principles of quantum mechanics and their relevance to quantum computing.
2. Examine different models of quantum computation and their engineering applications.
3. Analyse different machine learning models in quantum computing.
4. Apply quantum data encoding techniques and feature mapping methods for machine learning
5. Evaluate optimization challenges and limitations of quantum computing in engineering contexts.

Co-PO Mapping (scale 1: low, 2: Medium, 3: High)

CO-PO Mapping	PO1	PO2	PO3	PSO1	PSO2
CO1	1	1	2	2	2
CO2	2	1	3	3	3
CO3	2	1	3	3	3
CO4	2	1	3	3	3
CO5	2	1	3	3	3

Unit 1:	Introduction to Quantum Mechanics for Engineers	9 hours

Basic principles of quantum mechanics, Quantum states and observables, Superposition and entanglement, Quantum measurement and interference, Dirac notation and bra-ket notation.
Introduction to Qiskit, PennyLane and Ocean.

Unit 2	Quantum Computing Models and Architectures	9 hours

Introduction to gate-based quantum computing, Quantum gates and their operations, Single-qubit gates (Pauli gates, Hadamard gate, phase gate), Multi-qubit gates (CNOT gate, Toffoli gate), Quantum circuit representation and manipulation, Quantum circuit optimization techniques.
Qiskit Framework, Qiskit Terra to build circuits, Qiskit Aer simulation.

Unit 3	**Quantum algorithms for machine learning and pattern recognition**	**9 hours**

Overview of machine learning and its key concepts, Introduction to quantum machine learning and its motivations, Advantages and challenges of quantum machine learning, Comparison of classical and quantum machine learning algorithms, Quantum gates and circuits relevant to machine learning, Quantum states, measurements, and entanglement in the context of machine learning, Quantum algorithm design principles for machine learning tasks. Introduction to quantum support vector machines and quantum neural networks.

Unit 4	**Quantum Data Encoding and Feature Mapping**	**9 hours**

Classical data representation and encoding methods, Quantum data encoding techniques (amplitude encoding, quantum embeddings), Quantum feature mapping and kernel methods for machine learning, Quantum data pre-processing and dimensionality reduction techniques. Quantum nearest neighbor algorithms for pattern recognition.
Case studies showcasing quantum algorithms for pattern recognition tasks.

Unit 5	**Optimization problems and Quantum Computing**	**9 hours**

Overview of optimization problems and their significance, Classification of optimization, Formulation of optimization problems, Examples of optimization problems in different domains (logistics, finance, scheduling), Overview of classical optimization algorithms (gradient descent, simplex method, genetic algorithms).
Case studies demonstrating the application of classical optimization algorithms using PennyLane.

	Total Lecture hours	**45 hours**

Textbook

1. Combarro, E. F., & Gonzalez-Castillo, S. (2023). A Practical Guide to Quantum Machine Learning and Quantum Optimisation: Hands-On Approach to Modern Quantum Algorithms. Packt Publishing.
2. Johnston, E. R., Harrigan, N., & Gimeno-Segovia, M. (2019). Programming Quantum Computers: Essential Algorithms and Code Samples. "O'Reilly Media, Inc."

Reference Books

1. Jain, V., Juneja, S., Juneja, A., & Kannan, R. (2021). *Handbook of Machine Learning for Computational Optimization: Applications and Case Studies*. CRC Press.

Mode of Evaluation

MSE		**CA**			**ESE**	**Total**	
MSE1	**MSE2**	**CA1**	**CA2**	**CA3 (ATT)**			
30	**30**	**6**	**6**	**3**			
60		**15**			**75**	**150**	

Practical Courses Detail Syllabus

Course Code: CS501P	Course Name: Advanced Data Structures Lab	L	T	P	C
		0	0	2	1

Pre-requisite: Fundamentals of Data Structures & Algorithms

Course Objectives

1. Comprehensive understanding of advanced data structures, their applications, and design principles.
2. Ability to evaluate and analyze the efficiency of data structures for solving complex problems.
3. Hands-on experience in implementing advanced data structures through practical projects and programming assignments.

Course Outcome: After completion of the course, the student will be able to

1. Understand advanced physical data structures.
2. Explore the stack and queue data structures and its applications.
3. Explore the different variations of the Tree data structure and their characteristics
4. Demonstrate the representation and traversal techniques of graphs and their applications
5. Examine the different methods of searching and sorting to gain a deeper understanding of their distinct approaches and procedures.

CO-PO Mapping (scale 1: low, 2: Medium, 3: High)

CO-PO Mapping	PO1	PO2	PO3	PSO1	PSO2
CO1	0	1	3	3	2
CO2	1	0	2	3	2
CO3	1	0	3	3	2
CO4	1	0	2	3	2
CO5	1	0	2	3	2

List of Experiments (Indicative & not limited to)

Exp. No	Experiment Description- *Separate List will be attached*
1	Implement a dynamic array data structure. The dynamic array should support the following operations: ✓ Insertion of an element at a specific index. ✓ Deletion of an element from a specific index. ✓ Retrieval of an element from a specific index. ✓ Resizing the array when it reaches its capacity.
2	Implement a sorting algorithm that combines the merge sort and quick sort algorithms. Your task is to create a function that takes an unsorted list as input and returns a sorted list using the following approach: For small subarrays (e.g., less than 10 elements), use the quick sort algorithm to sort the subarray. For larger subarrays, use the merge sort algorithm to sort the subarray. Combine the sorted subarrays using the merge operation to obtain the final sorted list.
3	Implement a binary search algorithm to find the maximum element in a rotated sorted list. The list is rotated at a pivot point unknown to you. For example, the input [14, 5, 6, 7, 0, 1, 2] should return the index of the maximum element, which is 3 in this case.
4	Given a sorted list of integers that contains duplicates, find the count of a specific element using binary search. For example, in the list [1, 2, 2, 2, 3, 4, 5], the count of 2 is 3.
5	Implement a binary search algorithm to find the square root of a given positive integer with a specified precision. Return the square root rounded to the specified number of decimal places.
6	Given a list of words sorted lexicographically, implement a binary search algorithm to find the index of a specific word efficiently.

7	Implement a hash table using separate chaining for collision resolution. The hash table should support the following operations: Insertion of a key-value pair. Retrieval of the value associated with a given key. Deletion of a key-value pair. Displaying all the key-value pairs in the hash table.
8	Given a list of integers that represent a mountain peak, implement a binary search algorithm to find the peak element. A peak element is defined as an element that is greater than its neighbors.
9	Implement an AVL Tree data structure that supports the following operations: insert(key): Inserts a new node with the given key into the AVL Tree. delete(key): Deletes the node with the given key from the AVL Tree. search(key): Searches for a node with the given key in the AVL Tree and returns True if found, False otherwise. get_height(): Returns the height of the AVL Tree. print_tree(): Prints the AVL Tree in a readable format.
10	Write a program in to implement a threaded binary tree. Your program should include the following operations: ✓ Insertion: Implement a function to insert a node into the threaded binary tree. ✓ Deletion: Implement a function to delete a node from the threaded binary tree. ✓ Search: Implement a function to search for a specific value in the threaded binary tree. ✓ Traversal: Implement functions to perform in-order, pre-order, and post-order traversals of the threaded binary tree.
11	Write a program to implement a Huffman Tree. Your program should include the following operations: ✓ Frequency Calculation: Implement a function to calculate the frequency of characters in a given input string. ✓ Huffman Encoding: Implement a function to generate the Huffman encoding for each character based on their frequencies. ✓ Huffman Decoding: Implement a function to decode a given Huffman encoded string using the generated Huffman tree.
12	Write a program to implement a Breadth First Search (BFS)
13	Write a program to implement a Depth First Search (DFS)
14	Write a program to check a given graph is Connected or not.
15	Write a program to the number of connected components in a graph.
16	Given the root of a binary tree, return its maximum depth. A binary tree's maximum depth is the number of nodes along the longest path from the root node down to the farthest leaf node.
17	Given a binary tree, find its minimum depth. The minimum depth is the number of nodes along the shortest path from the root node down to the nearest leaf node. Note: A leaf is a node with no children.
18	Given the root of a binary tree, check whether it is a mirror of itself (i.e., symmetric around its center).
19	Given the root of a binary tree, invert the tree, and return its root.
20	Given the root of a binary tree, return the sum of all left leaves. A leaf is a node with no children. A left leaf is a leaf that is the left child of another node.
	Total Hour 30 hours

Course Code: CS502P	**Course Name: Data Science Foundation Lab**	**L**	**T**	**P**	**C**
		0	**0**	**2**	**1**
Pre-requisite: NA					
Course Objectives					

1. To understand the concept of data science, its role in addressing big data challenges, and its importance across industries.
2. To develop proficiency in data manipulation and analysis using SQL, including basic statistics, filtering, joins, aggregation, and window functions.
3. To comprehend the principles of effective data visualization, utilize Tableau to create visualizations, and design interactive dashboards.

Course Outcome : After completion of the course, the student will be able to

1. Articulate the fundamentals of data science and its relevance in addressing big data challenges.
2. Apply data manipulation techniques using SQL, including basic statistical operations.
3. Acquire the concept of data preprocessing, cleaning, and transformation.
4. Understand the concept of python language for graph plotting.
5. Develop critical thinking by making data-driven decisions and effectively communicating their findings through visualizations.

CO-PO Mapping (scale 1: low, 2: Medium, 3: High)

CO-PO Mapping	PO1	PO2	PO3	PSO1	PSO2
CO1	1	0	1	2	1
CO2	1	2	1	2	2
CO3	2	2	2	2	2
CO4	1	1	2	1	1
CO5	1	2	2	1	2

List of Experiments (Indicative & not limited to)

Experiment No.	Experiments
1	SQL for Data Analysis: Retrieving and Manipulating Data
2.	NoSQL Database Exploration and Querying
3.	Data Preprocessing Techniques: Cleaning and Integrating Data
4.	Exploratory Data Analysis using Python and pandas
5.	Statistical Analysis with Python: Descriptive Statistics and Inference
6.	Python for Data Science: Manipulating Data Frames with NumPy and pandas
7.	Time Series Analysis: Handling and Analyzing Time-Indexed Data
8.	Introduction to Tableau: Creating Basic Visualizations
9.	Designing Effective Dashboards in Tableau
10.	Advanced Chart Types in Tableau: Exploring Unique Visualizations

Total Hours 30 hours