SNDT Women's University, Mumbai

Master of Science in Computer Science (M.Sc.-CS.)

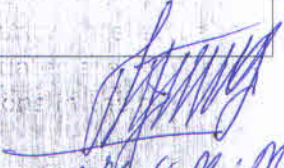## as per NEP-2020

Syllabus

(2023-24)

Dr. G. M. Magar
(BOS-chairperson)

Programme	Master of Science in Computer Science (M.Sc.-CS.)
Preamble	In unwavering commitment to the principles outlined herein, the Master of Science in Computer Science program steadfastly aims to shape an educational experience that empowers its students to excel as adept scholars, critical thinkers, and responsible leaders within their respective fields. By articulating these guiding principles, we underscore our dedication to fostering a transformative learning environment that goes beyond the acquisition of technical skills to cultivate holistic and forward-thinking professionals.
Programme Outcomes (POs)	After completing this programme, Learner will be able to • **Advanced Knowledge-**Demonstrated proficiency in fundamental and specialized computer science concepts, encompassing algorithms, data structures, artificial intelligence, machine learning, and relevant domains. • Critical Thinking and Problem Solving- Exhibited ability to analyze intricate problems, synthesize information, and apply critical thinking skills for the creation of innovative and effective solutions within the computer science field • **Advanced Technical Skills-**Possession of advanced technical skills in programming languages, software development, system design, and other pertinent areas, enabling the creation of robust and efficient computing solutions • **Ethical Considerations-**Displayed a strong understanding of ethical considerations in computer science, encompassing privacy, security, intellectual property, and societal impact. Graduates are equipped to make informed and ethical decisions in their professional practice. • **Lifelong Learning-**Embraced a commitment to lifelong learning, showcasing the ability to stay current with emerging technologies, industry trends, and advancements in computer science through self-directed learning and ongoing professional development.
Programme Specific Outcomes (PSOs)	Programme Specific Outcomes (PSOs) for an MSC in Computer Science specify the particular skills, knowledge, and abilities that students are expected to gain upon completion of the program.

	• **Advanced Technical Proficiency-**Demonstrate mastery of advanced concepts in computer science, including algorithms, data structures, databases, and software engineering, to design and implement complex computing solutions.
	• **Specialized Knowledge in Focus Areas-**Develop expertise in specific focus areas within computer science such as artificial intelligence, machine learning, cyber security, or data science, showcasing advanced knowledge and skills in these specialized domains.
	• **Research and Innovation-**Conduct independent research, including formulating research questions, designing experiments, and analyzing results, contributing to the creation of new knowledge and advancements in the field.
	• **Advanced Programming Skills-**Exhibit proficiency in various programming languages and paradigms, enabling the development of efficient and scalable software solutions.
	• **System Design and Architecture-**Design and architect complex computing systems, demonstrating an understanding of system-level considerations, scalability, and performance optimization.
	• **Effective Communication of Technical Information-**Communicate complex technical information effectively to both technical and non-technical audiences through written reports, presentations, and documentation.
	• **Innovation and Entrepreneurship-**Foster innovation and entrepreneurial thinking, demonstrating the ability to identify opportunities, propose creative solutions, and potentially contribute to startups or innovative projects.
Eligibility Criteria for Programme	A woman Graduate in BSc.(Physics), BSc.(Maths.), BSc.(Elect.), BSc.(IT),B.Sc.(CS) or BCA or any engineering graduate in allied subject from the recognized university with an aggregate marks not less than 50% (Open Category) and 45%(Reserved category).
Intake	60
Duration	4 semesters (2 years)

Master of Science in Computer Science(M.Sc.-CS.)

Year -I

Code	Subjects	Type of Course	Credits	Marks	Int.	Ext.
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115511	Operating Systems	Major (Core) Theory	4	100	50	50
115512	Data Communications and Networking	Major(Core) Theory	4	100	50	50
115513	Data Structures and Analysis of Algorithm	Major(Core) Theory	2	50	0	50
115524	Data Structures and Analysis of Algorithm- Lab	Major (Core) Practical	2	50	25	25
115525	Operating Systems-Lab	Major (Core) Practical	2	50	25	25
	Elective-I	Major (Elective) Theory	4	100	50	50
135511	Research Methodology	Minor Stream (RM) Theory	4	100	50	50
			22	550	250	300

Semester-II						
Code	Subjects	Type of Course	Credit	Marks	Int.	Ext.
215511	Data Warehousing and Data Mining	Major (Core) Theory	4	100	50	50``
215512	Database Management Systems	Major (Core) Theory	4	100	50	50
215513	Web Technology	Major (Core) Theory	2	50	50	0
215524	Database Management Systems-Lab	Major (Core) Practical	2	50	25	25
215525	Web Technology-Lab	Major (Core) Practical	2	50	25	25
	Elective-II-	Major (Elective) Theory	4	100	50	50
245541	OJT	OJT	4	100	50	50
			22	550	300	250

Exit option(44 credits):
Post Graduate Diploma in Computer Science

Year -II

Code	Subjects	Type of Course	Credit	Marks	Int.	Ext.
	Semester-III					
315511	Big Data Analytics	Major(Core) Theory	4	100	50	50
315512	Machine Learning	Major(Core) Theory	4	100	50	50
315513	Data Science	Major(Core) Theory	2	50	0	50
315524	Big Data Analytics-Lab	Major(Core) Practical	2	50	25	25
315525	Machine Learning-Lab	Major(Core) Practical	2	50	25	25
	Elective-III	Major(Core) Theory	4	100	50	50
355531	RP	RP	4	100	50	50
			22	550	250	300
	Semester-IV					
415511	Deep Learning	Major (Core) Theory	4	100	50	50
415512	Natural Language Processing	Major (Core) Theory	4	100	50	50
415513	Mobile Application Development using Android Programming	Major (Core) Practical	2	50	25	25
415524	Natural Language Processing-Lab	Major (Core) Practical	2	50	25	25
	Elective-IV/(MOOC/SWAYAM)	Major (Core) Theory	4	100	50	50
445541	Internship	RP	6	150	100	50
			22	550	300	250

Code	Elective-I	Code	Elective-II
125511	1.CyberSecurity	225511	1.EthicalHacking
125512	2.Digital ImageProcessing	225512	2.ProjectManagement
125513	3.SoftwareEngineering	225513	3.FuzzyLogic&NeuralNetwork
125514	4.ArtificialIntelligence	225514	4.IoT

Code	Elective-III	Code	Elective-IV
325511	1.Blockchain	425511	1.InformationSecurity
325512	2.GIS andRemoteSensing	425512	2.DigitalForensics
325513	3.SoftwareTesting	425513	3.AgileMethodology
325514	4.RoboticProcess Automation	425514	4.Cloud Computing

SN	Courses, Modules and Outcomes	Course Contents	Cr
	Semester I		
115511	**Operating Systems** **Major (Core) Theory**		**4**
	Course Outcomes: **Learners will be able to:** • Demonstrate a comprehensive understanding of computer-system organization and architecture. • Explain the fundamental structure and operations of operating systems. • Understand and implement strategies for optimizing overall system performance, considering processes, memory, file systems, and other critical components.		
Module 1	**Introduction to Operating Systems(OS)**		1
	LOs: Learners will be able to • Understand the fundamental organization and architectural components of computer systems. • Identify the interactions among hardware components in a computer system. • Describe the structure of operating systems and their key operational aspects. • Analyse the components that contribute to the effective functioning of an operating system. • Explain the concept of virtual machines in operating systems. • Evaluate the advantages and applications of virtualization.	**Module Contents:** • Computer-System Organization, Computer-System Architecture, Operating-System Structure, Operating-System Operations, Process Management, Memory Management, Storage Management, Protection and Security, Distributed Systems, Special-Purpose Systems, Computing Environments. • Operating-System Services, User Operating-System Interface, System Calls, Types of System Calls, System Programs, Operating-System Design and Implementation, Operating-System Structure, Virtual Machines, Operating-System Generation.	
Module 2	**Process , Memory and File Management**		1
	LOs: Learners will be able to • Explain the concept of processes in operating systems. • Analyze process scheduling algorithms and their implications for system performance. • Demonstrate knowledge of memory management techniques, including swapping, paging, and segmentation. • Evaluate virtual memory concepts, demand paging, and copy-on-write mechanisms.	**Module Contents:** • **Processor Management:** Process concept, Process scheduling, Operations on Processes, Inter-process Communication, Multithreading models, threading issues, Process scheduling algorithms, Thread scheduling, Multiple processor Scheduling. • **Process Coordination**: Synchronization, Semaphores, Monitors, Deadlocks characterization, Methods for handling deadlocks, Deadlock prevention, Deadlock Avoidance, Deadlock detection, recovery from deadlock.	

		• **Memory Management:** Swapping, Contiguous Memory Allocation, Paging, Structure of the Page Table, Segmentation • **Virtual memory Management:** Demand Paging, Copy-on-Write, Page replacement, Allocation of Frames, Thrashing.	
Module 3	**File, I/O and Disk Management**		1
	LOs: These learning outcomes aim to • Equip students with a thorough understanding of file, I/O, and disk management. • Differentiate between various file access methods and understand their applications. • Understand mechanisms for file sharing among processes and users. • Providing them with the knowledge and skills necessary for effective system storage and data handling in diverse computing environments. • Describe the components and characteristics of input/output hardware. • Understand the interaction between applications and the I/O subsystem. • Understand techniques for effective disk management. • Differentiate between various types of distributed operating systems. • Understand the characteristics and functionalities of each type. • Analyze mechanisms for remote file access in distributed file systems. • Understand the challenges and solutions associated with remote file access.	**Module Contents:** • **File Management:** File Concept, File Access Methods, Directory Structure, File Sharing, File Protection, File-System Structure, File-System Implementation, Directory Implementation, Allocation Methods, Free-Space Management, Efficiency and Performance, Recovery, Log-Structured File Systems, NFS. • **I/O Management**: I/O Hardware, Application I/O Interface, Kernel I/O Subsystem, Transforming I/O Requests to Hardware Operations, STREAMS, Performance. • **Disk Management:** Disk Structure, Disk Attachment, Disk Scheduling, Disk Management, Swap-Space Management, RAID Structure, Stable - Storage Implementation, Tertiary - Storage Structure • **Distributed systems:** Types of Distributed Operating, Network Structure, Network Topology, Communication Structure, Communication Protocols, Robustness, Design Issues. • **Distributed File Systems:** Naming and Transparency, Remote File Access, State full Versus Stateless Service, File Replication • **Distributed Coordination**: Event Ordering, Mutual Exclusion, Atomicity, Concurrency Control, Deadlock Handling, Election Algorithms, Reaching Agreement	
Module 4	**Protection and Security**		1
	LOs: Learners will be able to • Define and articulate the fundamental goals of protection in computing environments. • Understand how protection goals	**Module Contents:** **Protection and Security:** • Goals of Protection, Principles of Protection, Domain of Protection, Access Matrix, Implementation of Access Matrix, Access Control,	

	contribute to the overall security posture of a system. • Evaluate strategies for implementing access matrices in operating systems. • Understand the challenges and trade-offs associated with the practical implementation of access matrices.	Revocation of Access Rights, Capability-Based Systems, Language-Based Protection. • The Security Problem, Program Threats, System and Network Threats, Cryptography as a Security Tool, User Authentication, Implementing Security Defences, • Firewalling to Protect Systems and Networks, Computer-Security Classifications	

Assignments/ Activities		
	These assignments aim to cover diverse aspects of operating systems, encouraging practical application and critical thinking. • Computer Architecture Analysis: Analyze and propose improvements for specific computer architecture. • Operating System Structure Comparative Study: Compare structures of different operating systems, discussing pros and cons. Process Management Simulation: Develop a process management simulation model with scheduling algorithms. Memory Management Optimization: Propose optimizations for memory allocation in a specific operating system. • Storage Management Case Study: Analyse and evaluate the efficiency of a chosen storage management strategy. • Protection and Security Policies: Develop protection and security policies for a hypothetical environment. • Distributed Systems Design Project: • Special-Purpose Systems Investigation: Investigate a special-purpose operating system, analysing its applications. • Operating System Services and User Interface Evaluation: Evaluate services and propose improvements for user interface efficiency. • Virtual Machines Implementation: Implement a virtual machine, demonstrating benefits in resource utilization. • File Concept and Access Methods Analysis: • I/O Hardware Performance Analysis: • Compare and contrast different disk scheduling algorithms, discussing their efficiency.	

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Silberschatz, A., Galvin, P. B., & Gagne, G. (2005). Operating System Concepts (7th ed.). John Wiley and Sons, Inc.

Milenkovic, M. (n.d.). Operating Systems: Concepts And Design (2nd ed.). McGraw-Hill International Editions.

Stallings, W. (2005). Operating Systems: Internals and Design Principles (5th ed.). Prentice Hall.

Tanenbaum, A. S. (2001). Modern Operating Systems (3rd ed.). Pearson Education.

SN	Courses, Modules and Outcomes	Course Contents	Cr
	Semester I		
115512	**Data Communications and Networking** **Major (Core) Theory**		**4**
	Course Outcomes: **Learners will be able to:** • Define and explain key concepts in data communications. • Understand the OSI (Open Systems Interconnection) model and TCP/IP protocol suite. • Describe and differentiate between various networking protocols. • Analyze the functions and characteristics of key protocols such as TCP, UDP, IP, and HTTP. • Design and implement basic computer networks based on specific requirements. • Evaluate and select appropriate networking topologies and configurations.		
Module 1	**Introduction to Computer Networks**		1
	LOs: Learners will be able to • Understand the concept of computer networks and their significance in modern computing. • Explain the purposes and advantages of connecting computers in a networked environment. • Identify and differentiate between common network topologies. • Analyze the strengths and weaknesses of various topologies in different scenarios. • Explore various applications of computer networks in different domains (e.g., business, education, healthcare). • Analyze case studies to understand how networks are utilized to meet specific organizational needs.	**Module Contents:** • **Introduction:** Computer Networks and its uses, Network categorization and Hardware: Broadcast and point-to-point networks, Local Area Network (LAN), Metropolitan Area Network (MAN), Wide Area Networks (WAN), Inter networks, Topologies, Wireless Networks, Network Software: Protocols, Services, network architecture, design issues, OSI Reference model, TCP/IP Reference model, Comparison of OSI and TCP/IP Models. Introduction to Example Networks: Internet, Connection-Oriented Networks–X.25, Frame Relay, ATM • **Data Communication Model:** Digital and Analog data and signals, bit rate, baud, bandwidth, Nyquist bit rate, Guided Transmission Media – Twisted Pair, Coaxial cable, Optical fiber; wireless transmission–Radio waves, microwaves, infrared waves; Satellite Communication.	
Module 2	**Switching, Error Detection and Correction**		1
	LOs: Learners will be able to • Explain the concept of circuit switching in telecommunication networks. • Differentiate circuit switching from other switching techniques. • Describe the process of establishing a circuit in a circuit-switched network.	**Module Contents:** **Switching:** Circuit Switching, Packet switching; Multiplexing: Frequency Division Multiplexing, Time Division Multiplexing, Synchronous and Asynchronous TDM, Modems, Transmission impairments, Manchester and differential Manchester encoding **Error Detection and Correction:** Types of errors Redundancy,	

	• Analyze the advantages and disadvantages of circuit switching. • Explore common circuit switching protocols (e.g., ISDN). • Evaluate the efficiency and limitations of these protocols in different scenarios. • Describe how packets are routed and forwarded in a packet-switched network. • Explore routing algorithms used in packet switching.	Detection Versus Correction, Error Detection, Error Correction, Hamming Code, Cyclic Redundancy Check, Check sum and Its idea.	
Module 3	**Data Link Layer Design issues**		1
	LOs: These learning outcomes aim to • Explain the role of the Data Link Layer in the OSI model. • Differentiate between the functions of the Physical Layer and the Data Link Layer. • Discuss various framing techniques used in the Data Link Layer. • Implement framing algorithms for efficient data encapsulation and transmission	**Module Contents:** **Data Link Layer Design issues:** Framing, error control, Flow Control, Error Detection and correction; Elementary Data Link Protocols, Sliding Windows Protocols; Medium Access Control: Aloha, CSMA protocols, Collision free protocols, Limited Contention Protocols; Wave length division Multiple access protocol, Wireless LAN Protocol: MACA; IEEE 802.3Ethernet, IEEE 802.4 Token Bus; IEEE 802.5 Token ring, Binary Exponential Back off algorithm, Digital Cellular, Radio : Global System for Mobile, Communication (GSM), Code Division Multiple Access (CDMA)	
Module 4	**Network Layer, Design issues**		1
	LOs: Learners will be able to • Explain the purpose and functions of the Network Layer in the OSI model. • Differentiate between the responsibilities of the Network Layer and other layers. • Understand the concepts of addressing and routing at the Network Layer. • Design and implement addressing schemes for efficient packet routing. • Define virtual circuit switching and its advantages. • Compare and contrast virtual circuit switching with other switching techniques.	**Module Contents:** • Network Layer, Design issues Virtual circuit and Datagram Subnet, Routing Algorithms, Optimality principle, shortest path routing, Flooding, Distance Vector Routing, Link State Routing, Hierarchical Routing, Broadcast and Multi Cast Routing, Routing for Mobile hosts, Routing in Ad hoc Networks, congestion Control Algorithm, General Principals Traffic Shaping, Leaky Bucket, Token Bucket, choke packets, Load Shedding	

Assignments/ Activities	

Test students' understanding of fundamental concepts in data communications and networking.
• Apply knowledge of network design principles to solve a real-world scenario
• Present a case study involving a fictional organization with specific networking needs. Ask students to:
  ● Design a network topology that meets the organization's requirements.
  ● Specify the hardware and software components needed.
  ● Justify their design choices.
• Assign a lab exercise using network simulation software (e.g., Cisco Packet Tracer). Students should:
  ● Set up a small network with routers and switches.
  ● Configure IP addresses, routing protocols, and security features.
  ● Troubleshoot and resolve any connectivity issues.
• Conduct a mock interview where students take turns being the interviewer and interviewee. Questions can cover a range of topics, including:
  ● Troubleshooting network issues.
  ● Designing a network for specific requirements.
  ● Explaining complex networking concepts.	

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SN	Courses, Modules and Outcomes	Course Contents	Cr
	Semester I		
115513	**Data Structures and Analysis of Algorithm** **Major (Core) Theory**		**2**
	Course Outcomes: **Learners will be able to:** • Define and differentiate between arrays, linked lists, stacks, and queues. • Analyze the time and space complexities of basic data structure operations. • Implement basic data structures in a programming language of choice. • Debug and troubleshoot common issues related to data structure implementation. • Analyze the time and space complexities of algorithms. • Apply Big-O notation to express the upper bounds of algorithmic performance. • Apply advanced data structures to solve specific computational problems. • Evaluate the efficiency and suitability of data structures in different scenarios.		
Module 1	**Linear and Non-linear Data Structure**		1
	LOs: Learners will be able to • Define the concept of data structures and their role in organizing and storing data. • Differentiate between linear and non-linear data structures. • Identify and classify linear data structures such as arrays, linked lists, stacks, and queues. • Analyze the advantages and limitations of each linear data structure. • Understand tree structures, including binary trees and n-ary trees. • Implement tree traversal algorithms (e.g., in-order, pre-order, post-order). • Define graphs and their components (vertices and edges). • Implement basic graph traversal algorithms and graph-related operations	**Module Contents:** **Introduction:** Data types, ADT, data structure: Definition & classification Analysis of algorithms (recursive and non-recursive) with emphasis on best case, average case and worst case **Linear Data structures with applications:** **List**: Introduction, implementation using array & linked list (singly, doubly, circular, multi-list), Applications: Polynomial representation, Sparse matrix **Stack**: Introduction, implementation using array & linked list, Applications: Function call, Recursion, balancing of parenthesis, Polish Notation: infix to post fix conversion and evaluation of post fix expression **Queue**: Introduction (queue, circular queue, deque, priority queue), implementation using array &linked list, Applications: Job Scheduling **Non-Linear data structures:** **Tree**: Introduction **Graph**: Introduction, representations, Traversal (BFS, DFS), Applications: Shortest path (Single source-all destinations), Minimal spanning tree (Prim's	

		algorithm, Kruskal's algorithm)	
Module 2	**Searching, Sorting and Hashing**		1
	LOs: Learners will be able to • Explain the concept of hashing and hash functions. • Implement and analyse hash tables for efficient data retrieval • Apply data structures to solve real-world problems and scenarios. • Design and implement efficient algorithms for specific use cases. • Understand the linear search algorithm and its basic concepts. • Implement linear search in various scenarios. • Analyze the time and space complexity of linear search. • Compare and contrast the efficiency of various sorting algorithms. • Choose the most appropriate sorting algorithm for specific scenarios	**Module Contents:** **Searching and Sorting**: Linear Search, Binary Search, Transpose sequential search, Binary search tree, Heap tree (application in priority queue and sorting), AVL tree, Splay tree, M-way search tree, B tree (insertion), B+ tree (Definition and introduction), B*tree (Definition and introduction), Tries, Application of B tree and B+ tree in File Structures **Hash Tables**: Introduction, hash functions and hash keys, Collisions, Resolving collisions, Rehashing Sorting with algorithm analysis (best case, worst case, average): Bubble, Selection, Insertion, Shell, Merge, Quick, Heap, Radix **NP-Completeness and the P & NP Classes** Introduction, Polynomial Time & Verification, NP-Completeness and Reducibility, The Vertex Cover Problem, The Traveling Salesman Problem, The Set Covering Problem	
Assignments/ Activities			
	Test students' understanding of fundamental concepts in data structure and algorithms. • Apply and analyse basic array operations. • Analyse the time and space complexities of each operation. • Compare the performance of arrays with different sizes and data types. • Apply stack and queue data structures to real-world scenarios. • Understand and apply tree traversal algorithms. • Implement in-order, pre-order, and post-order tree traversal algorithms. • Apply tree traversal to solve problems such as expression tree evaluation. • Solve problems such as finding connected components in a graph. • Analyse the time and space complexities of the implemented algorithms.		

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Horowitz, E., Sahni, S., & Anderson-Freed, S. (2007). Fundamentals of Data Structures in C (2nd ed.). University Press.

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Knuth, D. E. (1973). Sorting and Searching: The Art of Computer Programming, Vol. 3. Addison-Wesley Publishing.

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SN	Courses, Modules and Outcomes	Course Contents	Cr
	Semester I		
115524	**Data Structures and Analysis of Algorithm-Lab** **Major (Core) Practical**		**2**
	Course Outcomes: **Learners will be able to acquire:** • Practical Skills: Acquire hands-on experience in implementing data structures and algorithms. • Proficiency: Develop a high level of proficiency in applying learned concepts. • Problem-Solving Competence: Demonstrate the ability to solve real-world problems using appropriate solutions. • Algorithmic Analysis: Gain skills in analyzing the time and space complexities of algorithms. • Optimization Techniques: Learn and apply optimization strategies to enhance algorithmic solutions. • Demonstration of Competence: Showcase competence in both theoretical understanding and practical application. • Application to Real-World Scenarios: Apply data structures and algorithms to address practical challenges effectively.		
Module 1	**Linear and Non-linear Data Structure**		1
	LOs: Learners will be able to • Write efficient, readable, and maintainable code for both linear and non-linear data structures. • Analyze the advantages and limitations of each linear data structure. • Implement tree traversal algorithms (e.g., in-order, pre-order, post-order). • Implement basic graph traversal algorithms and graph-related operations	**Module Contents:** **Linear Data structures with applications:** **List**: Introduction, implementation using array & linked list (singly, doubly, circular, multi-list), **Stack**: Implementation using array & linked list **Queue**: Introduction (queue, circular queue, deque, priority queue), implementation using array &linked list. **Non-Linear data structures:** **Tree**: **Graph**: Traversal (BFS, DFS), Applications: Shortest path (Single source-all destinations), Minimal spanning tree (Prim's algorithm, Kruskal's algorithm)	
Module 2	**Searching, Sorting and Hashing**		1
	LOs: Learners will be able to • Implement and analyse hash tables for efficient data retrieval • Apply data structures to solve real-world problems and scenarios. • Design and implement efficient algorithms for specific use cases. • Analyze the time and space complexity of linear search. • Compare and contrast the efficiency of various sorting algorithms. • Choose the most appropriate sorting algorithm for specific	**Module Contents:** **Searching and Sorting**: Linear Search, Binary Search, Transpose sequential search, Binary search tree, Heap tree (application in priority queue and sorting),	

	scenarios		
Assignments/ Activities			
	Test students' understanding of fundamental concepts in data structure and algorithms and implement the algorithms. • Implement common array operations (e.g., insertion, deletion, searching). • Implement and compare different types of linked lists. • Implement a stack and a queue. • Solve practical problems using stacks and queues (e.g., expression evaluation, breadth-first search). • Implement in-order, pre-order, and post-order tree traversal algorithms. • Implement basic operations on binary trees (e.g., insertion, deletion). • Implement depth-first search (DFS) and breadth-first search (BFS) algorithms.		

Bibliography:

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Gopal, A. (2006).Magnifying Data Structures. PHI Learning.

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SN	Courses, Modules and Outcomes	Course Contents	Cr
	Semester I		
115525	**Operating Systems-Lab** **Major (Core) Practical**		**2**
	Course Outcomes: **Learners will be able to acquire:** • These specific course outcomes aim to equip students with hands-on experience in implementing and experimenting with various operating system concepts and functionalities. • Students should be able to apply theoretical knowledge to practical scenarios, troubleshoot issues, and optimize system performance.		
Module 1	**File and System Commands**		1
	LOs: Learners will be able to • Successful OS installation in a virtual environment. • OS Installation: • Successful configuration in a virtual environment. • Proficient use of essential file commands. • Successful file system management (mounting, unmounting). • Monitor and manage processes using commands (top, ps, kill, killall). • Effective process monitoring, listing, and termination. • Proficient use of commands for system performance assessment. • Effective use of grep, egrep, and fgrep with regular expressions.	**Module Contents:** • Installation of OS on Virtual Machine (VM, Oracle BOX etc) • FileCommands:ls,cp,mv,rm,ln, cd,mkdir,rmdir,chown,chgrp,c hmod,gzip,tar,updated,find. • Commands to Access File Contents: cat, less, diff • File Systems: Mount, unmount • System Commands: System Information: df, du, free, Date • Processes: top, ps, kill, killall • Network: ping, nslookup, telnet • Other: IOSTAT, SAR, Pstat, Netstat command and its parameters. • The grep Family: The grep Command, grep Examples with Regular Expressions, grep with Pipes, grep with Options, egrep(Extended grep),Fixed grep or Fast grep	
Module 2	**Introduction to UNIX Shells**		1
	LOs: Learners will be able to • Implement and analyse hash tables for efficient data retrieval • Apply data structures to solve real-world problems and scenarios. • Design and implement efficient algorithms for specific use cases. • Analyze the time and space complexity of linear search. • Compare and contrast the efficiency of various sorting algorithms. • Choose the most appropriate sorting algorithm for specific scenarios	**Module Contents:** **Introduction to UNIX Shells:** Definition and Function, System Startup and the Login Shell, Processes and the Shell, The Environment and Inheritance, Executing Commands from Scripts. The Interactive Bourne Shell, The C Shell, The KornShell, The Interactivebash Shell Regular Expressions, Combining Regular Expression Meta characters ProgrammingwiththebashShell:In troductionSection,ReadingUserIn put,Arithmetic,PositionalParamet ersandCommandLineArguments, ConditionalConstructsandFlowCon trolSection,LoopingCommands,Fu nctionsSection,TrappingSignals,D	

		ebugging,ProcessingCommandLineOptionswithgetopts,TheevalCommandandParsing The Command Line, bash Options, Shell Built – In Commands.	
Assignments/ Activities			
	Test students' understanding of fundamental concepts in data structure and algorithms and implement the algorithms. • Implement common array operations (e.g., insertion, deletion, searching). • Implement and compare different types of linked lists. • Implement a stack and a queue. • Solve practical problems using stacks and queues (e.g., expression evaluation, breadth-first search). • Implement in-order, pre-order, and post-order tree traversal algorithms. • Implement basic operations on binary trees (e.g., insertion, deletion). • Implement depth-first search (DFS) and breadth-first search (BFS) algorithms.		

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Das, Sumitabha. (Year not specified). "Unix/Linux Programming." Publisher not specified.

SN	Courses, Modules and Outcomes	Course Contents	Cr
	Semester I		
125511	**Cyber Security** **Major (Elective) Theory**		**4**
	Course Outcomes: **Learners will be able to:** • Provide an overview of the field of Cyber Security, including its challenges, constraints, and the role of Internet governance. • Differentiate between various cyber threats, including Cyber Warfare, Cyber Crime, Cyber Terrorism, and Cyber Espionage. • Understand the imperative for a comprehensive Cyber Security policy, the establishment of a nodal authority, and the importance of an international convention on Cyberspace. • Identify vulnerabilities in software, system administration, network architectures, data access, authentication, broadband communications, and poor awareness. • Apply basic security measures for HTTP and SOAP services, understand identity management, authorization patterns, and address challenges in securing web applications. • Identify intrusion types, such as physical theft, privilege abuse, unauthorized access, malware infection, and implement techniques including anti-malware software, network-based intrusion detection/prevention systems, and host-based intrusion prevention systems.		
Module 1	**Introduction to Cyber Security**		1
	LOs: These learning outcomes aim to • Identify and understand vulnerabilities in software, system administration, complex network architectures, open access to organizational data, weak authentication, unprotected broadband communications, and poor Cyber Security awareness. • Demonstrate the ability to conduct security audits, identifying potential weaknesses in systems and networks. • Explain the role of cryptography in Cyber Security and apply cryptographic techniques to secure data communication. • Understand the concept of ethical hacking and its role in proactively identifying and addressing vulnerabilities. • Develop strategies for threat management, including proactive measures and response plans to mitigate the impact of potential cyber threats.	**Module Contents:** • **Introduction to Cyber Security** Overview of Cyber Security, Internet Governance–Challenges and Constraints, Cyber Threats:-Cyber Warfare-Cyber Crime-Cyber, terrorism-Cyber Espionage, Need for a Comprehensive Cyber Security Policy, Need for a Nodal Authority, Need for an International convention on Cyberspace • **Cyber Security Vulnerabilities and Cyber Security Safeguards** Cyber Security Vulnerabilities-Overview, vulnerabilities in software, System administration, Complex Network Architectures, Open Access to Organizational Data, Weak Authentication, Unprotected Broadband communications, Poor Cyber Security Awareness. Cyber Security Safeguards-Overview,Accesscontrol,Audit,Authentication,Biometrics,Cryptography, Deception, Denial of Service Filters, Ethical Hacking, Firewalls, Intrusion Detection Systems, Response, Scanning, Security policy, Threat Management.	

Module 2	Securing Web Application		1
	LOs: Learners will be able to • Define and explain the roles of services and servers in the context of web applications. • Apply fundamental security measures for HTTP applications, ensuring protection against common vulnerabilities. • Understand identity management principles and implement secure identity practices within web services. • Understand the implications of physical theft as a potential threat and implement measures to prevent or mitigate its impact. • Apply security measures to prevent and detect unauthorized access attempts by external entities.	**Module Contents:** • **Securing Web Application** Services and Servers Introduction, Basic security for HTTP Applications and Services, Basic Security for SOAP Services, Identity Management and Web Services, Authorization Patterns, Security Considerations, Challenges. • **Intrusion Detection and Prevention** Intrusion, Physical Theft, Abuse of Privileges, Unauthorized Access by Outsider, Malware infection, Intrusion detection and Prevention Techniques, Anti-Malware software, Network based Intrusion detection Systems, Network based Intrusion Prevention Systems, Host based Intrusion prevention Systems, Security Information Management, Network Session Analysis, System Integrity Validation	
Module 3	Cryptography and Network Security		1
	LOs: These learning outcomes aim to • Define cryptography and explain its role in securing information and communication. • Differentiate between symmetric and asymmetric key cryptography, and understand their applications in securing data. • Understand and apply cryptography in various applications, demonstrating proficiency in securing data in different contexts. • Analyze the specificities of the Indian cyber space, including its regulatory framework, challenges, and initiatives.	**Module Contents:** **Cryptography and Network Security:** Introduction to Cryptography, Symmetric key Cryptography, Asymmetric key Cryptography, Message Authentication, Digital Signatures, Applications of Cryptography. Overview of Firewalls- Types of Firewalls, User Management, VPN Security, Security Protocols:-security at the Application Layer-PGP and S/MIME, Security at Transport Layer-SSL And TLS, Security at Network Layer-IPSec. **Cyber space and the Law:** Introduction, Cyber Security Regulations, Roles of International Law, the state and Private Sector in Cyber space, Cyber Security Standards. The INDIAN Cyber space, National Cyber Security Policy 2013.	
Module 4	Analysis of Variance and Co-variance		1
	LOs: learning outcomes aim to • Define Cyber Forensics and understand its significance in investigating cybercrimes and digital incidents. • Demonstrate the ability to initiate and conduct preliminary investigations in response to	**Module Contents:** **Cyber Forensics** Introduction to Cyber Forensics, Handling Preliminary Investigations, Controlling an Investigation, Conducting disk-based analysis, Investigating Information-hiding, Scrutinizing E-mail, Validating E-	

	suspected cyber incidents, ensuring the preservation of digital evidence. • Develop proficiency in conducting disk-based analysis, including the identification, preservation, and analysis of digital evidence stored on computer hard drives and storage media.	mail header information, Tracing Internet access, Tracing memory in real-time.	
Assignments/ Activities			
	These assignments and activities are designed to engage students in practical applications of cyber security concepts, fostering critical thinking and skill development throughout the course. • Divide students into groups and assign each group a specific cyber security vulnerability (e.g., software vulnerabilities, weak authentication). Have them research, analyze, and present strategies to mitigate the assigned vulnerability. • Organize a workshop where students present and demonstrate various cyber security safeguards. This can include access control, encryption, firewalls, and intrusion detection systems. Encourage hands-on activities and practical demonstrations. • Assign students a case study involving a web application. They should conduct a security assessment, identify vulnerabilities, and propose safeguards. Emphasize securing HTTP and SOAP services, identity management, and authorization patterns. • Provide case studies related to intrusion incidents. Students should analyze each case, identify the type of intrusion, and propose effective prevention and detection techniques. Encourage discussion on ethical hacking and security policy enforcement. • Provide legal cases related to cyber space and cyber security. Students should analyze the legal implications, court decisions, and the role of international law and regulations. • Assign students to review and critique the National Cyber Security Policy of 2013. They should assess its effectiveness, identify areas for improvement, and propose updated recommendations.		

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SN	Courses, Modules and Outcomes	Course Contents	Cr
	Semester I		
125512	**Digital Image Processing** **Major (Elective) Theory**		**4**
	Course Outcomes: **Learners will be able to:** • Demonstrate a comprehensive understanding of light, brightness adaptation, discrimination, and the human visual system in the context of digital images. • Analyze and interpret images as 2D data, distinguishing between grayscale and color representations, and demonstrate proficiency in image sampling and quantization techniques. • Apply image filtering techniques in both spatial and frequency domains, including concepts such as image smoothing, sharpening, homomorphic filtering. • Understand the reasons for image degradation, model the image degradation/restoration processes, and implement noise probability density functions. • Describe color fundamentals, color models, and apply pseudo-color image processing techniques for enhanced visual representation. • Understand the fundamentals of redundancies and implement basic compression methods.		
Module 1	**Fundamentals of Digital Image Processing**		1
	LOs: These learning outcomes aim to • Understand the concept of light and its role in digital imaging. • Explore brightness adaptation and discrimination in the context of human vision. • Examine the basics of the Human Visual System (HVS) and its relevance to image processing. • Comprehend the representation of images as 2D data. • Differentiate between gray scale and color images in terms of representation and characteristics. • Study the concepts of image sampling and quantization. • Understand the concept of an image histogram and its role in image processing. • Understand the fundamentals of spatial filtering. • Explore spatial filtering masks for low-pass filtering (smoothing) and high-pass filtering (sharpening).	**Module Contents:** • Light, brightness adaption and discrimination, Human visual system, Image as a 2D data, Image representation gray scale and color images, Image Sampling and quantization. • Intensity transformation functions: Contrast stretching, Thresholding, Image negative, Log transformation, Power-low	

Module 2	**Image Enhancement and Restoration**	1
	LOs: Learners will be able to • Understand preliminary concepts related to image filtering in the frequency domain. • Extend concepts to functions of two variables in the context of image processing. • Explore image smoothing techniques in the frequency domain. • Study image sharpening methods in the frequency domain. • Gain knowledge of 2D-DFT (2-dimensional Discrete Fourier Transform) and its significance. • Learn image restoration using spatial filtering techniques such as mean filters, order statistic filters, and adaptive filters.	**Module Contents:** • **Image filtering in the Spatial and frequency domain:** Preliminary Concepts, Extension to functions of two variables, Image Smoothing, Image Sharpening, Homomorphic filtering,2D-DFT, 2DFFT, 2D-DCT, Fundamentals of 2D-wavelet transform, Image pyramids, sub-band coding. • **Image restoration:** Reasons for image degradation, Model of image degradation/restoration process, Noise probability density functions, Image restoration using spatial filtering (Mean filters, Order statistic filters and adaptive filters), Inverse Filtering, MMSE (Wiener)Filtering	
Module 3	**Colour Image Processing and Image Compression**	1
	LOs: These learning outcomes aim to • Demonstrate a comprehensive understanding of color fundamentals, including the concepts of color spaces, color models, and the perceptual aspects of color. • Analyze and apply various color models, such as RGB, CMYK, and HSL, to represent and manipulate color information in digital images. • Understand the fundamental concepts of redundancies in digital images and recognize opportunities for compression. • Understand and apply wavelet-based compression techniques for both lossless and lossy compression, considering their advantages in preserving image details.	**Module Contents:** • **Color Image Processing:** Color Fundamentals, Color Models, Pseudo-color image processing. • **Image Compression:** Fundamentals of redundancies, Basic Compression Methods: Huffman coding, Arithmetic coding, LZW coding, JPEG Compression standard, Wavelet based image compression.	
Module 4	**Image Segmentation and Morphological Image Processing**	1
	LOs: learning outcomes aim to • Understand the concept of edge-based segmentation in image processing. • Explore region-based segmentation techniques and their applications. • Gain knowledge about region split and merge techniques for image segmentation.	**Module Contents:** • **Image Segmentation:** Edge based segmentation, Region based segmentation, Region split and merge techniques, Region growing by pixel aggregation, optimal thresholding. • **Morphological Image Processing:** Basic morphological operations, Erosion, dilation, opening, closing,	

	• Understand the region-growing approach using pixel aggregation. • Understand the basic principles of morphological operations in image processing. • Explore the concept of structuring elements and their role in morphological operations. • Explore basic morphological algorithms, including holefilling and connected components.	Structuring elements, Hit-or-Miss transform, Basic Morphological Algorithms: hole filling, Connected components, thinning, skeletons, Reconstruction by erosion and dilation	
Assignments/ Activities			
	Assignments: Basic Image Enhancement Techniques • Apply fundamental image enhancement techniques to improve the visual quality of a given grayscale image. • Select a grayscale image with varying intensity levels. • Implement contrast stretching, histogram equalization, and gamma correction on the image. • Provide visual comparisons of the original image and the enhanced versions. • Explain the impact of each enhancement technique on image quality. • Discuss potential applications where each technique might be beneficial. • Implement basic image compression algorithms and evaluate their impact on image quality and file size. • Select a high-resolution color image for compression. • Implement Huffman coding for lossless compression and evaluate the compression ratio. • Apply JPEG compression with different quality settings and observe the trade-off between compression ratio and image quality. • Compare the original and compressed images visually. • Discuss the strengths and limitations of each compression method. • Assignments based on important topics, spatial and frequency domain filtering		

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SN	Courses, Modules and Outcomes	Course Contents	Cr
	Semester I		
125513	**Software Engineering** **Major (Elective) Theory**		**4**
	Course Outcomes: **Learners will be able to:** • Understand structured development methodologies and various models like agile or waterfall. • Recognize the pivotal role of Software Requirements Specification (SRS) in documenting software needs. • Estimate costs, create timelines, allocate resources efficiently, implement quality assurance, and manage risks. • Adhere to effective coding, thorough verification, and engage in testing methodologies. • Demonstrate knowledge beyond development, covering maintenance, risk management, and project management concepts.		
Module 1	**Software Processes, Software Requirement Analysis and Specification**		1
	LOs: These learning outcomes aim to • Understand the concepts of software processes, projects, and products. • Examine component software processes and their roles in the development lifecycle. • Identify the characteristics of a software process and how they influence project outcomes. • Investigate the software configuration management process and its importance. • Define software requirements and recognize the need for Software Requirement Specification (SRS). • Understand other modeling approaches, such as prototyping, and their relevance to requirement analysis. • specification languages and their application in documenting requirements. • Examine the structure of a requirement document and its components.	**Module Contents:** • **Software Processes:** Processes projects and products, Component software processes, characteristics of a software process, software Development Process, project management process, software configuration management process, software configuration management process, and process management process • **Software requirement Analysis and Specification:** Software requirement, need for SRS, requirement process, problem analysis, analysis issues. Informal approach, structured analysis, object-oriented modelling, other modelling approaches, prototyping, requirement specification, characteristics of an SRS, component of an SRS, specification languages, structure of requirement document validation requirement reviews, other method metrics, size measures, quality metrics	
Module 2	**Planning Software Project and Coding**		1
	LOs: Learners will be able to • Understand best practices in coding and programming. • Explore verification techniques in coding. • Identify size measures in the context of coding and programming.	**Module Contents:** • **Planning Software Project:** Cost estimation, uncertainties in cost estimation, building cost estimation models, on size estimation, COCOMO model, project scheduling, average duration estimation, project scheduling and	

	- Perform complexity analysis in coding. - Understand the fundamentals of software testing. - Explore white-box testing techniques. - Understand control structure testing and its role in software testing. - Explore black-box testing techniques. - Understand basis path testing in the context of software testing. - Explore code walk-throughs and inspections in the testing process. - Understand different testing strategies and the associated issues. - Explore unit testing in software development. - Understand integration testing and its significance.	milestones, staffing and personnel planning, ray leigh curve, personnel plan, team structure, software configuration management plans, quality assurance plans, verification and validation, project monitoring plans, risk management. • **Coding:** Programming practice, verification, size measures, complexity analysis, coding standards. Testing– fundamentals, white box testing, control structure testing, black box testing, basis path testing, code walk-throughs and inspection, testing strategies-Issues, Unit testing, integration testing, Validation testing, System testing	
Module 3	**Maintenance**		1
	LOs: These learning outcomes aim to - Understand the overall process of software maintenance and its significance in the software development lifecycle. - Identify and differentiate between various types of maintenance activities. - Explore the challenges and considerations involved in software maintenance. - Define software risks and recognize their impact on software projects. - Explore techniques for identifying potential risks in software projects. - Understand the process of monitoring and managing software risks. - Understand the fundamental concepts of project management. - Explore the interplay between people, product, process, and project in the context of software development.	**Module Contents:** • **Maintenance**: Overview of maintenance process, types of maintenance. Risk management: software risks-risk identification-risk monitoring and management. Project Management concept: People–Product-Process-Project.	
Module 4	**Protection and Security**		1
	LOs: Learners will be able to Understand the basic concepts of project scheduling and tracking in software development.	**Module Contents:** • **Project scheduling and tracking:** Basic concepts-relation between	

		people and effort-defining task set for the software project-selecting software engineering task Software configuration management: Basics and standards User interface design-rules. Computer aided software engineering tools-CASE building blocks, taxonomy of CASE tools, integrated CASE environment.	
	• Explore the relationship between people and effort in the context of project scheduling. • Learn how to define a task set for a software project, considering the scope, complexity, and dependencies. • Understand the basics of software configuration management (SCM) and its importance in software development. • Explore industry standards and best practices in software configuration management. • Understand the basics of CASE tools and their role in the software development lifecycle. • Explore the rules and principles of user interface design in the context of software development. • Learn about the building blocks of CASE tools and how they contribute to the development process.		
Assignments/ Activities			
	These assignments aim to cover diverse aspects of software engineering. • Choose a software project scenario and develop a project schedule, considering task dependencies and the allocation of resources. Discuss the challenges and benefits of the chosen scheduling approach. • Investigate the relationship between the effort required for project tasks and the team involved. Propose strategies for optimizing team efficiency while ensuring project success. • Define a task set for a hypothetical software project. Consider factors such as task complexity, dependencies, and critical path analysis. Justify your choices in the task set. • Research and document the basics of software configuration management, including its key principles and objectives. Explain how effective SCM contributes to successful software development. • Explore industry standards for software configuration management. Compare and contrast different standards, highlighting their advantages and limitations. • Investigate the building blocks of CASE tools and how they contribute to the software development process. Provide examples of each building block in action. • Develop a taxonomy of CASE tools, categorizing them based on their functions and applications. Discuss the advantages and limitations of different types of CASE tools.		

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SN	Courses, Modules and Outcomes	Course Contents	Cr
	Semester I		
125514	**Artificial Intelligence** **Major (Elective) Theory**		**4**
	Course Outcomes: **Learners will be able to:** • Demonstrate an overview of Artificial Intelligence, recognizing its importance in various fields. • Trace the historical development of AI and identify related fields. • Explain different methods of representing knowledge in AI. • Understand and apply knowledge base systems. • Analyze state space search problems using examples like the 8-Queens, Traveling Salesman, and others. • Understand adversarial search in game scenarios. • Implement the minimax algorithm and comprehend Alpha-Beta Pruning for optimizing game strategies. • Represent simple facts using logic. • Understand computable functions in predicates. • Apply resolution and unification techniques. • Differentiate between forward and backward reasoning.		
Module 1	**Introduction to Artificial Intelligence**		1
	LOs: These learning outcomes aim to • Demonstrate a comprehensive understanding of Artificial Intelligence (AI), including its definition, objectives, and significance in various domains. • Trace the historical development of AI, identifying key milestones, breakthroughs, and influential figures in the field. • Explain various methods of representing knowledge in AI, including symbolic, semantic, and sub-symbolic approaches. • Implement and interpret Knowledge Base Systems for organizing and managing information.	**Module Contents:** **Introduction:** • Overview of AI, Importance of AI, History, related fields, Representation of Knowledge, Knowledge Base Systems, State Space Search Problem Characteristics of 8- Queens, Traveling Salesman, Missionary & Cannibals, Crypt, Arithmetic, Monkey Banana Problem, Tower of Hanoi and Block World.	
Module 2	**Searching Methods and Predicate & Logic**		1
	LOs: Learners will be able to • Implement DFID to combine the advantages of DFS and BFS. • Assess the efficiency of DFID in terms of time and space complexity. • Apply Greedy Best-First Search to solve optimization problems. • Analyse the role of heuristic functions in guiding the search process. • Implement Hill Climbing Search for local optimization. • Recognize the limitations and	**Module Contents:** **Searching Methods:** • Uninformed Search Methods: Breadth First Search (BFS), Depth First Search (DFS), Depth Limited Search, Depth First Iterative Deepening (DFID), • Informed Search Methods: Greedy best first Search, A* Search, Memory bounded heuristic Search. • Local Search Algorithms and Optimization Problems: Hill	

		challenges associated with hill climbing. • Apply genetic algorithms for optimization and problem-solving. • Understand the principles of genetic algorithms and their application in various domains. • Represent and manipulate simple facts using propositional and first-order logic. • Understand the syntax and semantics of logic representations	climbing search Simulated annealing, Local beam search, Genetic algorithms. • Adversarial Search: Games, Optimal strategies, The minimax algorithm, Alpha-Beta Pruning. **Predicate & Logic:** • Representing simple facts in Logic -Computable functions in predicates, resolution – unification • – forward vs. backward reasoning., Probabilistic reasoning – Bayes's Theorem – Certainty Factors– Demphster–Shafer Theory – Fuzzy, Sets, Reasoning with Fuzzy Logic, Natural Language Computation with Fuzzy Logic.	
Module 3	**Structured Knowledge Representation and Introduction to Natural Language Processing**		1
	LOs: These learning outcomes aim to • Explain the concept of associative networks in structured knowledge representation. • Implement and interpret associative networks for organizing and retrieving information. • Design and implement frame structures for organizing complex knowledge representations. • Analyze the role of frames in representing attributes, relationships, and hierarchies • Provide an overview of linguistics and its relevance to natural language processing. • Understand key linguistic concepts that influence language understanding.	**Module Contents:** • **Structured Knowledge Representation:** Associative Networks, Semantic Nets, Frames Structures, Conceptual, Dependencies & Scripts, Learning – Concept of Learning – Learning Automata, Learning by induction. • **Natural Language Processing**: Overview of Linguistics, Grammars and Languages, basic Parsing techniques, semantic analysis, and representation structures. Natural Language generation and Natural Language Systems.	
Module 4	**Expert System**		1
	LOs: learning outcomes aim to • Understand the architecture of expert systems, including knowledge representation, inference engines, and user interfaces. • Design and implement an expert system architecture for specific	**Module Contents:** **Expert Systems:** • Architecture – Need and Justification of • Expert Systems –Knowledge acquisition and validation. Perception and Action, Real time search, perception, action, vision, robot architecture,	

	problem domains. • Recognize and justify the need for expert systems in various industries and applications. • Evaluate the advantages and limitations of expert systems compared to traditional problem-solving approaches.	Learning in Neural Networks – Applications – Hopfield Networks, Back propagation, • Case Study - XCON, PROSPECTOR	
Assignments/ Activities		
	Recognize and analyse the practical applications of AI in everyday life. • Identify three applications of AI in daily life (e.g., virtual assistants, recommendation systems, smart home devices). • Describe how each application uses AI techniques. • Discuss the impact of these AI applications on efficiency, convenience, and user experience. • Reflect on potential ethical considerations associated with the use of AI in these applications. • Choose three AI algorithms (e.g., Decision Trees, Neural Networks, Genetic Algorithms). • Explain the working principles of each algorithm. • Compare and contrast their strengths, weaknesses, and applications. • Provide examples of real-world problems each algorithm can solve effectively. •	

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SN	Courses, Modules and Outcomes	Course Contents	Cr
	Semester I		
135511	**Research Methodology** **Major (Core) Theory**		**4**
	Course Outcomes: **Learners will be able to:** • Demonstrate an understanding of the key steps involved in the research process, including problem formulation, literature review, data collection, analysis, and interpretation. • Formulate clear and focused research questions and hypotheses based on a thorough review of existing literature and identification of research gaps. • Evaluate and select suitable research designs based on the nature of the research questions, including experimental, quasi-experimental, and non-experimental designs. • Conduct comprehensive literature reviews to identify relevant studies, theories, and methodologies within a specific research domain. • Develop and design appropriate tools for data collection, such as surveys, interviews, or experiments, ensuring validity and reliability. • Apply basic statistical techniques for data analysis, interpretation, and drawing meaningful conclusions from research findings • Understand and adhere to ethical considerations in research, including the responsible conduct of research, protection of human subjects, and avoidance of plagiarism.		
Module 1	**Introduction to Research methodology**		1
	LOs: These learning outcomes aim to • Provide students with a comprehensive understanding of research methodology, from the conceptualization of a research problem to the implementation of various research designs and sampling techniques. • Define and articulate the concept of research, including its significance, purpose, and applications in various fields. • Develop the skills necessary to define a clear and focused research problem, including the identification of gaps in existing literature and formulating relevant research questions. • Recognize the need for a well-structured research design and understand its features, purpose, and role in the overall research process.	**Module Contents:** • Research methodology: An Introduction Objectives of Research, Types of Research, Research Methods and Methodology, Defining a Research Problem, Techniques Involved in Defining a Problem. • Research Design. Need for Research Design, Features of Good Design, Different Research Designs, Basic Principles of Experimental Designs, Sampling Design, Steps in Sampling Design, Types of Sampling Design, Sampling Fundamentals, Estimation, Sample size Determination, Random sampling.	

Module 2	**Measurement and Scaling Techniques**		1
	LOs: Learners will be able to • Understand the role of measurement in the research process and its significance in obtaining accurate and reliable data. • Differentiate between various measurement scales, including nominal, ordinal, interval, and ratio scales, and apply them appropriately in research contexts. • Identify and analyse sources of error in measurement, exploring ways to minimize and control errors for enhanced data validity. • Define scaling in the context of research and recognize its importance in measuring attitudes, opinions, and other abstract concepts. • Acquire skills in constructing scales, exploring various techniques such as Likert scales, semantic differential scales, and other methods for effective measurement • Explore and evaluate methods for collecting primary and secondary data, considering the strengths and limitations of each approach. • Comprehend the role of statistics in research, including its application in summarizing data, making predictions, and testing hypotheses.	**Module Contents:** **Measurement and Scaling Techniques:** • Measurement in Research, Measurement Scales, Sources in Error, Techniques of Developing Measurement Tools, Scaling, Meaning of Scale, Scale Construction Techniques., • Methods of Data Collection and Analysis Collection of Primary and Secondary Data, Selection of appropriate method Data Processing Operations, Elements of Analysis, Statistics in Research, Measures of Dispersion, Measures of skewness, Regression Analysis, Correlation.	
Module 3	**Techniques of Hypotheses**		1
	LOs: These learning outcomes aim to • Understand the concept of hypotheses in research and explore techniques for formulating clear and testable hypotheses. • Differentiate between parametric and non-parametric tests, grasping the basic concepts underlying parametric tests. • Explore techniques for comparing variances between groups, understanding the significance of variance analysis in statistical testing.	**Module Contents:** • Techniques of Hypotheses, Parametric or Standard Tests Basic concepts, Tests for Hypotheses I and II, Important parameters limitations of the tests of Hypotheses, Chi-square Test, Comparing Variance, as a non-parametric Test, Conversion of ChitoPhi, Caution in using Chi-square test.	

	• Identify and analyze important parameters used in hypothesis testing, such as significance level (alpha), p-value, and critical values.		
Module 4	**Analysis of Variance and Co-variance**		1
	LOs: learning outcomes aim to • Equip students with the knowledge and skills necessary for advanced statistical analysis, including ANOVA, ANOCOVA, and various multivariate analysis techniques like factor analysis and path analysis. Students will be able to apply these techniques to analyze and interpret complex data sets effectively. • Define and articulate the fundamental goals of protection in computing environments. • Explore the concepts of path analysis, understanding the relationships among variables and the direct and indirect effects in a structural equation model. • Classify and differentiate between various multivariate analysis techniques, understanding their applications in complex data sets.	**Module Contents:** • Analysis of Variance and Co-variance ANOVA, One way ANOVA, Two Way ANOVA, ANOCOVA Assumptions in ANOCOVA, Multivariate Analysis Technique Classification of Multivariate Analysis, factor Analysis, R-type Q Type • factor Analysis, Path Analysis	
Assignments/ Activities			
	These assignments and activities are designed to engage students in practical applications of research methodology concepts, fostering critical thinking and skill development throughout the course. • Research Proposal Development: • Assignment: Ask students to develop a research proposal for a hypothetical research study. The proposal should include a clear research problem statement, objectives, literature review, research questions/hypotheses, methodology, and potential challenges. • Critical Analysis of Research Articles: • Activity: Provide students with a set of research articles from different disciplines. Ask them to critically analyse the methodology section, identifying strengths and weaknesses, and discussing how they would improve the research design. • Survey Design and Implementation: • Assignment: Have students design a survey on a topic of their choice. They should consider question wording, response options, and survey structure. After designing the survey, ask them to administer it to a small sample and analyse the results. • Qualitative Research Design: • Activity: Assign students a qualitative research design task. They can choose a research question and develop a plan for data collection (e.g., interviews, focus groups, observation). Emphasize the importance of reflexivity and ethical considerations. • Sampling Exercise: • Assignment: Provide a scenario where a specific sampling strategy is		

needed (e.g., population survey, clinical trial). Ask students to justify their choice of sampling method, discuss potential biases, and propose alternatives.
- Data Analysis with Statistical Software:
- Activity: Introduce students to statistical software (e.g., SPSS, R) and provide a dataset. Ask them to perform basic data analysis, including descriptive statistics and inferential tests. Emphasize interpretation of results.
- Ethical Dilemmas in Research:
- Assignment: Present students with various ethical dilemmas related to research (e.g., informed consent, data confidentiality). Ask them to analyse the dilemmas, propose solutions, and discuss the implications of their decisions.
- Peer Review Simulation:
- Activity: Have students conduct a peer review of a research proposal or a manuscript. This can include evaluating the clarity of the research question, appropriateness of methodology, and overall rigor of the study.
- Research Presentation:
- Assignment: Ask students to create a presentation summarizing a research paper. They should highlight the key elements of the study, discuss the methodology, and present the findings. Encourage a focus on effective communication.
- Case Study Analysis:
- Activity: Provide students with a research-related case study involving methodological challenges. Ask them to analyze the case, identify issues, and propose solutions based on their understanding of research methodology.

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SN	Courses, Modules and Outcomes	Course Contents	Cr
	Semester II		
215511	**DATA WAREHOUSING AND DATA MINING** **Major (Core) Theory**		**4**
	Course Outcomes: **Learners will be able to:** • Understanding of Data Warehousing Concepts. • Design and implement a data warehouse schema, considering factor dimension hierarchies. • Explain the importance of metadata in data warehousing and develop strategies for managing metadata to support data governance and data lineage. • Understand and apply various data mining algorithms, such as classification, clustering and association rule mining.		
Module 1	**Overview And Concepts Data Warehousing:**		1
	LOs: Learners will be able to • Understand the basic concepts of data warehousing, including data warehouse architecture, components, and its role in decision support systems. • Design and implement a data warehouse schema, considering factors such as star schema, snowflake schema, and dimension hierarchies.	**Module Contents:** • Need for data warehousing, Basic elements of data warehousing, Trends in data warehousing. • Project planning and management, collecting the requirements. • Architectural Components, Infrastructure and metadata. • Principles of dimensional modeling, Dimensional modeling advanced topics, data extraction, transformation and loading, data Quality.	
Module 2	**Information Access And Delivery, Implementation, Maintenance and Data Mining**		1
	LOs: Learners will be able to • Understand Extract, Transform and Load processes from source systems, transform it for analysis, and load it into the data warehouse. • Integrate data from diverse sources into a organized and unified data warehouse, addressing issues related to data quality and consistency. • Define data mining and understand its role in extracting valuable patterns, trends, and insights from large datasets.	**Module Contents:** • Information Access And Delivery: Matching information to classes of users, OLAP in data warehouse, Data warehousing and the web. • Implementation And Maintenance: Physical design process, data warehouse deployment, growth and Maintenance. • Data Mining: Introduction Basics of data mining, related concepts, Data mining techniques. • Data Mining Algorithms: Classification, Clustering, Association rules.	

Module 3	**Web Mining and Visualizations**		1
	LOs: Learners will be able to	**Module Contents:**	
	• Extracting useful information, patterns, and knowledge from web data. • Understand and apply various data mining algorithms, such as clustering, classification, regression, association rule mining, and anomaly detection. • Exploring and pre process data for mining, including handling missing values, and transforming variables for better analysis.	• Knowledge Discovery: KDD Process • Web Mining: Web Content Mining, Web Structure Mining, Web Usage mining. • Advanced Topics: Spatial mining, Temporal mining. Visualisation : Data generalization and summarization-based characterization, Analytical characterization : analysis of attribute relevance, Mining class comparisons: Discriminating between different classes, Mining Descriptive statistical measure sing large databases	
Module 4	**Data Mining Primitives, Languages, and System Architecture, Applications and Trends in Data Mining**		1
	LOs: Learners will be able to	**Module Contents:**	
	• Analyse popular data mining tools and software to implement and experiment with different algorithms and techniques. • Identify and implement strategies for the performance of data warehouse queries, including indexing, partitioning Exploring the different Trends and application in data mining	• Data Mining Primitives, Languages, and System Architectures: Data mining primitives, Query language, Designing GUI based on a data mining query language, Architectures of data mining systems • Application and Trends in Data Mining: Applications, Systems products and research prototypes, Additional themes in data mining, Trends in data mining	
Assignments/ Activities			
	These assignments aim to apply theoretical concepts to practical application and critical thinking. • Discuss the importance of metadata in data warehousing, to create a metadata management plan for a given data warehouse, outlining how metadata will be collected, stored, and utilized. • From a dataset extract relevant information, transform it according to a predefined business rule, and load it into a data warehouse. • Create a set of business queries related to a hypothetical business problem • Find a dataset suitable for clustering analysis. then use clustering algorithms to identify natural groupings within the data and interpret the results.		

	• web mining project (perform web scraping, and apply web mining techniques)	

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Ponnian, Paulraj. *Data Warehousing Fundamentals.* John Wiley.

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Kimball, Ralph. *The Data Warehouse Lifecycle Toolkit.* John Wiley.

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Inmon, W. H. *Building the Data Warehouse.* Wiley Dreamtech.

Mallach, E. G. *Decision Support and Data Warehouse Systems.* TMH.

SN	Courses, Modules and Outcomes	Course Contents	Cr
	Semester II		
215512	**Database Management Systems Major (Core)**		**4**
	Course Outcomes: **Learners will be able to:** • Understand fundamental concepts, overview and structure of database system. • Design database and analyse using E-R and Relational Model. • Implement and manage database with proficiency in SQL. • Understand transaction and implement recovery techniques. • Get information of object oriented and NoSQL databases.		
Module 1	**Introduction to Database model**		1
	LOs: Learners will be able to • Understand core concept of database system • Design and synthesized E-R model and Relational model	**Module Contents:** • **Introduction:** Database System application, Database System versus File systems, View of Data, Data Models, Database Languages, Database Users and administrator. DBA Roles and activity, Database system structure. • **Entity-Relational Model:** Basic Concepts ,Constraints, Keys, Entity-Relationship Diagram, Weak Entity Sets, Extended E-R features, Design of E-R Database Schema, Reduction of an E-R Schema to Tables • **Relational model:** Structure of Relational Databases, Relational Algebra, Tuple Relational Calculus, Domain Relational Calculus	
Module 2	**SQL and Database Design**		1
	LOs: Learners will be able to • Write and understand SQL commands with application of constraints in different scenarios. • Understand the concept of PL/SQL and Triggers • Demonstrate decomposition of databases and normalizing data using normalization	**Module Contents:** • **SQL:** SQL commands , Functions, Data Constraints, Grouping Data, Sub-queries, Joins, Performance Tuning, Security Management ,PL/SQL, Triggers. • **Integrity & Security:** Domain Constraints, Referential Integrity, Assertions, Triggers, Privileges in SQL. • **Relational Database Design:** Functional Dependencies, Decomposition, Normalization-1NF-5NF,BCNF	

Module 3	Storage and Transactions		1
	LOs: Learners will be able to • Understand concept of RAID • Analyze the concept of hashing and indexing • Demonstrate the concept of transactions	**Module Contents:** • **Storage & File Structure :**RAID , Improvement of Reliability & Performance Indexing & Hashing – Basic Concepts, Ordered Indices, B+ & B Tree Index Files, Static & Dynamic Hashing, Comparison of Ordered Indexing & Hashing. • **Transactions:** Transaction Concept & State, Implementation of Atomicity & Durability, Serializability, Recoverability, Testing for Serializability.	
Module 4	Concurrency control and Recovery system		1
	LOs: Learners will be able to • Compare and implement concurrency control protocol • Classify failure in database system and implement recovery techniques. • Understand and analyze object oriented Databases • Evaluate NoSQL databases.	**Module Contents:** • **Concurrency Control:** Protocols-Lock Based, Timestamp-based, Validation Based, Deadlock Handling & Concurrency • **Recovery System:** Failure Classification, Storage Structure, Recovery & Atomicity, Log based Recovery, Shadow Paging, Recovery with Concurrent Transactions, Buffer management, failure with loss of non volatile storage, advanced recovery techniques. • **Object–Oriented Databases:** New Database Applications, Object–Oriented Data Model, Object-Oriented Languages, Persistent Programming Languages, Persistent C++Systems. • **Introduction, Overview of NoSQL Databases**–Four Types of NoSQL (Document-oriented, Key Value Pairs, Column-oriented and Graph).	
Assignments/ Activities towards CCE			
	• Design database schema and E-R diagram for real-time/given scenario. • Store and manipulate the information for given schema using SQL. • Demonstrate the concept of constraints • Demonstration of Indexing and Hashing		

	• Implement the concept of Transaction and Recovery system using real-time/given schema. • Implement concurrency control protocol. • Demonstrate the concept of object-oriented database and NoSQL databases.	

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Korth, Henry, Abraham Silberschatz, and S. Sudarshan. *Database System Concepts.* 5th Edition. McGraw-Hill.

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Ramakrishnan, Raghu, and Johannes Gehrke. *Database Management Systems.* McGraw-Hill International Edition, 2002.

Hoffer, Jeffrey A., Mary Prescott, and Fred McFadden. *Modern Database Management.* 7th Edition. Prentice Hall, 2004.

Rob, Peter, and Carlos Coronel. *Database Systems: Design, Implementation and Management.* Thomson Publication, 2004.

Kroenke, David M. *Database Processing: Fundamentals, Design, Implementation.* 10th Edition. Prentice-Hall, 2005.

O'Neil, Patrick. *Database Principles Programming Performance.* 2nd Edition. Morgan Kaufmann Publishers, Inc., 2000.

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SN	Courses, Modules and Outcomes	Course Contents	Cr
	Semester II		
215513	**Web Technology** **Theory** **Major(Core)**		**2**
	Course Outcomes: **Learners will be able to:** • Design and implement HTML forms with various input elements, understanding form validation and user interaction. • Develop responsive web pages using HTML and CSS to ensure optimal viewing experience across different devices and screen sizes • Demonstrate the configuration and administration of a web server. Discuss the concept of virtual hosting and its implementation.		
Module 1	**Web technology and scripting Languages**		1
	LOs: Learners will be able to • Understand overview of HTTP, covering its basics, client requests, server responses, and common HTTP headers. Discuss the significance of persistent connections and cookies in session management. • Create well-formed and valid XML documents. Define Document Type Definitions (DTD) and explore the Document Object Model (DOM) in XML. • Develop dynamic and interactive web pages using JavaScript, including the use of variables, functions, loops, and conditional statements.	**Module Contents:** • **Introduction to Web Technologies:** Concepts of Internet, Concepts of World Wide Web, Internet based Services- Email, Telnet, FTP,WWW,Web Server, Web Hosting, DNS, SMTP. **HTML:** Introduction to HTML, Structure of HTML document, Basic HTML tags. Introduction to HTML5. **Angular JS:** Environment Setup, Creating and executing angular js application, directives, • controllers, expressions, filters, tables, modules, forms, views, scopes, services. • **CSS:** Introduction to CSS, Types of CSS- use of <div>&<span> in CSS, Introduction of CSS3 : Gradients, Transitions, Animations, multiplecolumns. • **XML:** Introduction to XML, Valid and Well- Defined Document, Document Type Definition or DTD, uses of DTD, XML Tags, Elements, Attributes, PCDATA, CDATA, XML Schema, Defining, Accessing XMLDocument. • **Clint Side Scripting Language: Javascript:** Introduction to javascript, Variables, identifiers constants, Operators in javascripts, , Eventhandling javascript,	

		Validations inJavaScript.	
Module 2	**Server side scripting**		1
	LOs: Learners will be able to • Understanding Structure • Understand the role of server-side scripting in web development. Compare various server-side scripting languages and their use cases. • Implement server-side scripts using PHP to handle server-side logic, database interactions, and dynamic content generation. •	**Module Contents:** • Structure ofHTMLDocument – Meta tags, **JQuery:** • Introduction to JQuery, Selectors, attributes, Traversing, CSS, DOM, Events, AJAX, Effects, Interactions, Widgets,Theming. • **Server Side Scripting Language: PHP** Configuration and Installation, Basic Structure of PHP script COOKIE variables, Sending E-mail, Database Operations with PHP, Connecting to My-SQL. CMS: Wordpress • Introduction to CGI Programming, JSP, Servlet, AJAX. Creation of .jar project. Deployment of Java application on Appserver.	
Assignments/ Activities			
	These assignments aim to apply theoretical concepts to practical application and critical thinking. • Creating an HTML document that includes various elements such as meta tags, links, text, lists, tables, and multimedia content. Apply styles, alignment, fonts, and frames to present the HTML document effectively. • Create well-formed and valid XML documents. Define Document Type Definitions and explore the Document Object Model in XML. • Develop a thread-safe servlet that can handle multiple concurrent requests. Discuss the challenges associated with thread safety in servlets. • Assign a project where students integrate various technologies covered in the course to develop a complete web application. This could include HTML, client-side scripting, server-side scripting, and deployment on Apache Tomcat.		

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Flanagan, David. *JavaScript: The Definitive Guide.* O'Reilly and Associates.

Buser, David, et al. *Beginning ASP 3.0.* Wrox.

SN	Courses, Modules and Outcomes	Course Contents	Cr
	Semester II		
215524	**Database Management system Lab: Practical Major (Core)**		**2**
	Course Outcomes: **Learners will be able to:** • Create and managing databases using database management system(like oracle, MySQL etc) • Write and execute SQL queries efficiently. • Create and execute Triggers, procedures etc. • Implement transaction management.		
Module 1	**Creating Databases**		1
	LOs: Learners will be able to • Implement Database schema with constraints. • Evaluate Normalization, Joining and different clauses.	**Module Contents:** • Database, Table Creation • Defining Schema, Constraints, Normalization • SQL Basic Queries • Joining, and Clause's implementation	
Module 2	**Procedure , Functions and Triggers**		1
	LOs: Learners will be able to • Evaluate execution of procedures, function, trigger, cursor and function etc • Illustrate concept of PL/SQL	**Module Contents:** • Procedure, Function execution • PLSQL Script Execution • Stored Procedure, Function, Packages Execution • Cursor, Trigger Writing	
Assignments/ Activities towards Comprehensive Continuous Evaluation			
	• Evaluate different database schemas with SQL commands • Illustrate the concept of normalization , SQL joins using different clauses. • Evaluate execution of Function, Trigger, Procedure etc		

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SN	Courses, Modules and Outcomes	Course Contents	Cr
	Semester II		
215525	**Web Technology Lab: Practical Major (Core)**		**2**
	Course Outcomes: **Learners will be able to:** • Understand basic to advance concept of web technology like frontend, database and backend like PHP. • Illustrate the PHP language. • Evaluate and Illustrate different web features. • Understand different web services with MVC architecture.		
Module 1	**Introduction to Web Technology**		1
	LOs: Learners will be able to • Explore the concept of HTML, CSS and JavaScript. • Illustrate the concept of MySQL and PHP. • Analyse server side scripting language PHP. • Install and use Xampp web server.	**Module Contents:** • Introduction to Web Technology, HTML, Basic Tags, CSS, Table and Forms • Introduction to JavaScript, Variables, Operators, Data Type Conversions, functions, Control Structure, Date-Time functions and Form Manipulation • MYSQL – Introduction about Database, Data Types, DML, DDL, Aggregate functions, Data Time functions, Stored Procedure, Sub query and join • PHP-Introduction to PHP, History, Web Brower, Web Server, Xampp, Installation and Configuration files. • Syntax, Operators, Variables, Constants, Control, Structure, Language construct and functions • Function–Syntax, Arguments, Variables, References, Returns and Variable Scope • Arrays-Enumerated Arrays, Associative array, array iteration, Multi-dimensional array, Array function and SPL Date and Time functions. Arrays-Enumerated Arrays, Associative array, array iteration, Multi-dimensional array, Array function and SPL Date and Time functions. • OOP's–Instantiation, Modifiers, Inheritance, Interfaces, Exceptions, Static Methods and Properties, Auto load, Reflection,	

		Type Hinting and Class Constance.	
Module 2	**Features of Web Technology**		1
	LOs: Learners will be able to • Understand different web features like sessions and forms, cookies etc. • Analyze the Ajax concept from basic. • Demonstrate and use Joomla. • Explore the MVC architecture and web services related to cakePHP.	**Module Contents:** • String and Patterns-Quoting, Matching, Extracting, Searching, Replacing and Formatting • Web Features-Sessions, Forms, GET and POST data, Cookies, HTTP Headers. Database Programming. • Streams and Network Programming- Files, Reading, Writing, File System functions, Streams File Uploading and File Downloading. • Ajax Basics, Sending data to PHP with Ajax, Prototype- Utility functions, Ajax object and Form Object. Smarty variables, Variable Modifiers, Built-in Functions, custom functions, Config files. • Introduction to Joomla • CakePHP - MVC Overview, Naming Conversions, Model, V\view, Controller, Helpers, Scaffolding an Data Validation, Security, Web Services	
Assignments/ Activities towards Comprehensive Continuous Evaluation			
	• Design and develop web pages using HTML and CSS. • Implement concepts of HTML and CSS for frontend development. • Illustrate the concept of JavaScript for web development. • Add the feature of database to website to store data using MySQL framework. • Implement backend of web development using PHP server side scripting language. • Illustrate different web services using all web technologies using Xampp server and Ajax . • Demonstrate the web development using Joomla. • Understand the working of CakePHP with MVC architecture and web services provided by it.		

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Powel, Thomas A. *PHP: The Complete Reference.*

Powel, Thomas A. *AJAX: The Complete Reference.*

SN	Courses, Modules and Outcomes	Course Contents	Cr
	Semester II		
225511	**Ethical Hacking** **Major (Elective) Theory**		**4**
	Course Outcomes: **Learners will be able to:** • Understand the core concepts related to malware, hardware and software vulnerabilities and their causes. • Understand ethics behind hacking and vulnerability disclosure. • Appreciate the Cyber Laws and impact of hacking. • Exploit the vulnerabilities related to computer system and networks using state of the art tools and technologies.		
Module 1	**Introduction to Ethical Disclosure:**		1
	LOs: Learners will be able to • Define and understand fundamental concept of Ethical hacking. • Understand ethics of hacking • Comprehend legal surrounding of ethical hacking. • Apply protocols for proper and ethical disclosure of security vulnerabilities.	**Module Contents:** • Ethics of Ethical Hacking, Ethical Hacking And the legal system, Proper and Ethical Disclosure	
Module 2	**Penetration Testing and Tools**		1
	LOs: Learners will be able to • Used Penetration testing tool efficiently. • Develop skills using Metasploit which is penetration testing tool with demonstration of BackTrack.	**Module Contents:** • Using Metasploit, Using BackTrack Live CDLinux Distribution.	
Module 3	**Vulnerability Analysis and Client-side browser exploits**		1
	LOs: • Understand and differentiate different vulnerability analysis technique. • Develop expertise in advanced reverse engineering methodologies • Apply Sulley's Intelligent fuzzing technique to find exploit weaknesses.	**Module Contents:** • **Vulnerability Analysis:** Passive Analysis, Advanced Static Analysis with IDA Pro, Advanced Reverse Engineering. • **Client-side browser exploits:** Exploiting Windows Access Control Model for Local Elevation Privilege, Intelligent Fuzzing with	

		Sulley, From Vulnerability to Exploit.	
Module 4	**Malware Analysis**		1
	LOs: Learners will be able to • Understand Fundamentals of malware • Define the Hacking malware. • Describe way to collect and analyse the malware • Illustrate the case study	**Module Contents:** • **Malware Analysis:** Collecting Malware and Initial Analysis, Hacking Malware. • Case study of vulnerability of cloud platforms and mobile platforms & devices	
Assignments/ Activities towards CCE			
	• Consider given/ real-time security scenario. • Apply the penetration testing using penetration tool • Perform vulnerability analysis on scenario. • Check for client side browsing exploits using Sulley's Intelligent fuzzing. • Perform malware analysis by collecting and analysing malware. • Explore case study.		

Bibliography:

Harris, Shon, Allen Harper, Chris Eagle, and Jonathan Ness.

Gray Hat Hacking: The Ethical Hackers Handbook. TMH Edition.

Erickson, Jon. *Hacking: The Art of Exploitation.* SPD.

SN	Courses, Modules and Outcomes	Course Contents	Cr
	Semester II		
225512	**PROJECT MANAGEMENT** **Elective Theory**		**4**
	Course Outcomes: **Learners will be able to:** • Understanding Project Management Fundamental concepts. • Develop skills in creating project plans, Identify, assess, and manage project risks by developing risk management plans. • Explore software testing methodologies and quality assurance practices to ensure the reliability and functionality of software deliverables. • Define and implement configuration identification processes and version control systems to manage changes and track the evolution of software throughout the project.		
Module 1	**Project Management Framework**		1
	LOs: Learners will be able to • Understanding fundamental project management concepts, including project scope and objectives. • Define different project life cycle models (e.g., Waterfall, Agile, Iterative) and understand when to apply each based on project requirements. • Identify the software scope statement for better estimates of cost and schedule.	**Module Contents:** • Overview of project Management, Project Organization, Planning a s/w project, Project management life cycle, Risk management, Identification of Risks, Risk Analysis, Risk Planning & Monitoring • S/w Project Estimation: Project Estimation , Different methods of estimation (COCOMO model, Delphi cost estimation etc.), Function point analysis	
Module 2	**Project Management Tools, Techniques and Software Management, Testing & Quality Assurance**		1
	LOs: Learners will be able to • Apply techniques for gathering, analyzing, and managing software requirements, ensuring clarity, completeness, and alignment with end users needs. • Understand the fundamentals of software testing, its goals, and its role in ensuring the quality of software products. • Understand the principles and objectives of quality assurance in software development,	**Module Contents:** • Project Management Tools & Techniques PERT & Gantt Charts, Introduction to Microsoft Project • Software Quality Management & Testing • Quality Assurance & Standards, Quality Planning, Quality control Role of testing in Software development , Testing Procedure, Defect Management	

	emphasizing prevention over detection.	
Module 3	**Configuration Management(CM):**	1
	LOs: Learners will be able to • Define and implement configuration identification processes and version control systems to manage changes and track the evolution of software throughout the project.	**Module Contents:** • CM planning, Change Management, Version and Release Management, Configuration Management
Module 4	**S/W Team Management:**	1
	LOs: Learners will be able to • Understand role of Team and the user in various software management stages. • Analyse the Team structure, behaviour and role of team and end user.	**Module Contents:** • S/W Team Management: • Characteristics of Performance management, High performance Directive and collaborative styles, Team Structure, Team Communication, Managing customer expectations, Group Behaviour Role of User in Projects, User role in project management, User role in various stages of, S/W Development User role in System ,implementation.
Assignments/ Activities		
	These assignments aim to apply theoretical concepts to practical application and critical thinking. • Develop a comprehensive software project proposal. The proposal should include project objectives, scope, deliverables, milestones, risks, and a preliminary project plan. • Design a quality assurance plan for a software project. They should identify key quality metrics, testing strategies, and processes for ensuring the overall quality of the software. • Assign readings or case studies that highlight project proposal, risk management plan for a given software project scenario.	

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Kelkar, S.A. *Software Project Management.*

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Whitten, J.L., L.D. Bentley, and K.C. Dittman. *Systems Analysis and Design Methods.*

SN	Courses, Modules and Outcomes	Course Contents	Cr
	Semester II		
225513	**Fuzzy Logic and Neural Network Elective Theory**		**4**
	Course Outcomes: **Learners will be able to:** • Understanding Fuzzy Set membership functions, and fuzzy operations. • Understanding basic concepts of neural networks, including neurons, layers, weights, and activation functions. • Design and implement feed forward neural networks for tasks such as pattern recognition and classification. • Understand and apply the back propagation algorithm for training neural networks, including concepts like gradient descent and error minimization.		
Module 1	**FUNDAMENTALS OF FUZZY LOGIC**		1
	LOs: Learners will be able to • Define and differentiate between crisp sets and fuzzy sets, explaining the concept of membership degrees and their role in handling uncertainty. • Explore compatibility relations and their role in defining the degree to which two fuzzy sets can coexist or overlap. • Understand the concept of morphisms in fuzzy sets, exploring how transformations can be applied to fuzzy sets while preserving their structure.	**Module Contents:** • Basic concepts: fuzzy set theory-basic concept of crisp sets and fuzzy sets- complements- union intersection- combination of operation- general aggregation operations- fuzzy relations-compatibility relations-orderings-morphisms- fuzzy relational equations-fuzzy set and systems	
Module 2	**ARCHITECTURE OF NEURAL NETWORKS**		1
	LOs: Learners will be able to • Understanding Motivation for Neural Networks • Explore different types of artificial neural networks, including feedforward, recurrent, and convolutional neural networks. • Understand the typical architecture of artificial neural networks, including layers and demonstrate the ability to set and adjust weights and biases in neural networks, understanding their impact on the network's performance.	**Module Contents:** • Architectures: motivation for the development of natural networks-artificial neural networks-biological neural networks-area of applications-typical Architecture-setting weights-common activations functions Basic learning rules- Mcculloch-Pitts neuron-Architecture, algorithm, applications-single layer net for pattern classification- Biases and thresholds, linear separability - Hebb'srule- algorithm -perceptron -Convergence theorem-Delta rule	

Module 3	BASIC NEURAL NETWORK TECHNIQUES		1
	LOs: Learners will be able to	**Module Contents:**	
	• Define and explain the fundamental components of a neural network, including neurons, layers, weights, biases, and connections.	• Back propagation neural net: standard back propagation-architecture algorithm- derivation of learning rules number of hidden layers--associative and other neural networks- hetro associative memory neural net, auto associative net- Bidirectional associative memory-applications-Hopfield nets-Boltzman machine	
Module 4	**COMPETITIVE NEURAL NETWORKS**		1
	LOs: Learners will be able to	**Module Contents:**	
	• Understand the architecture and principles of Kohonen Self-Organizing Maps, a popular competitive learning algorithm. • Demonstrate how competitive learning can be used for feature mapping, where neural networks learn to represent high-dimensional data in a lower-dimensional space. • Understand the hierarchical structure of the Neocognitron, including the arrangement of layers and the flow of information, and how it enables the network to recognize complex patterns. • Analyse the difference of fuzzy and neural system	• Neural network based on competition: fixed weight competitive nets- Kohonenself organizing maps and applications-learning vector quantization-counter propagation nets and applications adaptive resonance theory: basic architecture and operation-architecture, algorithm, application and analysis of ART1 & ART2 • Neocognitron - Architecture, training algorithm and application-fuzzy associate memories, fuzzy system architecture- comparison of fuzzy and neural system	
Assignments/ Activities			
	These assignments aim to apply theoretical concepts to practical application and critical thinking. • performing basic fuzzy set operations, including union, intersection, and complement, using real-world examples • implement a single-layer perceptron for a binary classification task, and analyse its performance on different datasets. • Create a feedforward neural network for a specific problem, define its architecture, and train it using backpropagation.		

Bibliography:

Kosko, Bart. *Neural Networks and Fuzzy Logic: A Dynamical Systems*

Approach to Machine Intelligence.* Prentice Hall.

SN	Courses, Modules and Outcomes	Course Contents	Cr
	Semester II		
225514	**IoT (Internet Of Things)** **Major (Elective) Theory**		**4**
	Course Outcomes: **Learners will be able to:** • Understand the fundamental concepts of IoT. • Differentiate between M2M and IoT. • Aware about different challenges have to face in IoT. • Explore different network and communication aspect in IoT. • Aware about different IoT tools. • Illustrate different application areas of IoTs. • Implement IoT concept using Python Fundamentals.		
Module 1	**Fundamentals of IoT**		1
	LOs: Learners will be able to • Define IoT and explore core concept of IoT. • Explore communication model and APIs used in IoT. • Understand and Differentiate between IoT and M2M.	**Module Contents:** • Introduction to IoT , Defining IoT, Characteristics of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Communication models & APIs • IoT & M2M Machine to Machine, Difference between IoT and M2M, Software define Network	
Module 2	**Network and Communication aspects**		1
	LOs: Learners will be able to • Aware about wireless medium access issues. • Understand the concept of MAC protocol survey and explore Survey routing protocols. • Describe data aggregation and dissemination. • Analyse the different challenges face while using IoTs.	**Module Contents:** • Network & Communication aspects Wireless medium access issues, MAC protocol survey, Survey routing protocols, Sensor deployment & Node discovery, Data aggregation & dissemination • Challenges in IoT Design challenges, Development challenges, Security challenges, Other challenges	
Module 3	**Applications of IoT**		1
	LOs: • Explore different application domains of IoT	**Module Contents:** • Domain specific applications of IoT Home automation, Industry applications, Surveillance applications, Other IoT applications	

Module 4	IoT Development		1
	LOs: Learners will be able to • Illustrate fundamental concepts of Python • Explore different python based IoT tools • Demonstrate the IoT concepts using Python.	**Module Contents:** • **Developing IoTs** : Introduction to Python, Introduction to different IoT tools, Developing applications through IoT tools, Developing sensor based application through embedded system platform, Implementing IoT concepts with python.	
Assignments/ Activities towards CCE			
	• Explore the fundamentals of IoTs with real-time application of IoT. • Differentiate IoTs with M2M and explain concept of Software defined network (SDN). • Explore the different challenges faced in IoTs with help of realtime example. • Explore the applications of IoTs. • Comprehend the network and communication aspect issues in IoTs. • Refine the use of Python for implementing IoT concepts. • Synthesize the IoTs concept based application implementation.		

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Madisetti, Vijay, and Arshdeep Bahga. *Internet of Things: A Hands-On Approach.*

Dargie, Waltenegus, and Christian Poellabauer. *Fundamentals of Wireless Sensor Networks: Theory and Practice.*

> **Exit:**
> **On completion of 44 credits, if student wish to exit the Programme, then, student will get Post Graduate Diploma in Computer Science (PGD in CS)**

SN	Courses, Modules and Outcomes	Course Contents	Cr
	Semester III		
315511	**BIG DATA ANALYTICS** **Major (Core) Theory**		4
	Course Outcomes: **Learners will be able to:** • Understand IBM's approach to big data and analytics. • Understand the flow of data in a Hadoop ecosystem. • Describe the steps involved in processing and analyzing data in Hadoop. • Explain the Hive data warehousing and SQL-like query language. • Describe the services and architecture of Apache Hive.		
Module 1	**INTRODUCTION TO BIG DATA AND HADOOP, HDFS (Hadoop Distributed File System)**		1
	LOs: Learners will be able to • Understanding the various types of digital data, including structured, semi-structured, and unstructured data. • Grasping the fundamental concepts of Big Data, including the three V's (Volume, Velocity, Variety). • Understanding the challenges and opportunities presented by Big Data. • Developing skills in using Unix tools for data analysis.	**Module Contents:** • Types of Digital Data, Introduction to BigData, BigData Analytics, History of Hadoop, Apache Hadoop, Analyzing Data with Unix tools, Analyzing Data with Hadoop, Hadoop Streaming, Hadoop Echo System, IBM Big Data Strategy, Introduction to Info sphere Big Insights and BigSheets. • The Design of HDFS, HDFS Concepts, Command Line Interface, Hadoop file system interfaces, Data flow, Data Ingest with Flume and Scoop and Hado oparchives, Hadoop I/O: Compression, Serialization, AvroandFile-Based Datastructures	
Module 2	**MapReduce**		1
	LOs: Learners will be able to • Understanding the key components and phases involved in a MapReduce job. • Exploring the sequence of steps from job submission to completion. • Understanding the job	**Module Contents:** • Anatomy of a Map Reduce Job Run, Failures, Job Scheduling,ShuffleandSort,TaskExecution,MapReduceTypesandFormats,MapReduceFeatures	

		scheduling process in a MapReduce framework. • Exploring how tasks are scheduled and allocated resources in a distributed environment.		
Module 3	**Hadoop EcoSystem**			1
	LOs: Learners will be able to • Learning about the different execution modes of Pig, including local and MapReduce modes. • Understanding the advantages and use cases for each execution mode. • Understanding the syntax and semantics of Pig Latin, the scripting language for Pig. • Learning to write Pig Latin scripts for data processing tasks.	**Module Contents:** • Pig: Introduction to PIG, Execution Modes of Pig, Comparison of Pig with Databases, Grunt, Pig Latin, User Defined Functions, Data Processing operators. Hive : Hive Shell, Hive Services, HiveMetastore,ComparisonwithTraditionalDatabases,HiveQL,Tables,QueryingDataandUserDefinedFunctions.Hbase:HBasics,Concepts,Clients,Example,HbaseVersus RDBMS. Big SQL :Introduction		
Module 4	**Data Analytics with R Machine Learning:**			1
	LOs: Learners will be able to • Understanding the significance of big data in the analytics landscape. • Exploring the challenges and opportunities posed by large-scale data.	**Module Contents:** • Introduction, Supervised Learning, Unsupervised Learning, Collaborative Filtering. Big Data Analytics with Big R.		
Assignments/ Activities				
	These assignments aim to apply theoretical concepts to practical application and critical thinking. • Set up a small Hadoop cluster or use a cloud environment. • Assign tasks where students perform common HDFS operations using the command line interface. • Assign a case where students need to optimize the scheduling of MapReduce jobs. • Consider factors such as resource utilization, data locality, and overall cluster efficiency. • Provide a dataset and task students with building a supervised learning model using Big R.		

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SN	Courses, Modules and Outcomes	Course Contents	Cr
	Semester III		
315512	**Machine Learning** **Major (Core)**		**4**
	Course Outcomes: **Learners will be able to:** • Recognize real-world examples and applications of machine learning. • Define and comprehend the principles of unsupervised learning. • Grasp the concepts of subset selection for dimensionality reduction. • Handle multiclass classification using One vs One and One vs Rest approaches.		
Module 1	**Introduction :**		1
	LOs: Learners will be able to • Understand the role of machine learning in automating tasks and making predictions. • Understand the importance of splitting data into training and testing sets for model evaluation.	**Module Contents:** • **Introduction:** What is Machine Learning, Examples of Machine Learning applications, Training versus Testing, Positive and Negative Class, Cross- validation. • Types of Learning: Supervised, Unsupervised and Semi-Supervised Learning. • Dimensionality Reduction: Introduction to Dimensionality Reduction, Subset Selection, Introduction to Principal Component Analysis.	
Module 2	**Binary and Multiclass Classification:**		1
	LOs: Learners will be able to • Define and interpret a confusion matrix. • Understand how true positives, true negatives, false positives, and false negatives contribute to classification assessment.	**Module Contents:** • Assessing Classification Performance, Handling more than two classes, Multiclass Classification-One vs One, One vs Rest Linear Models: Perceptron, Support Vector Machines (SVM), Soft Margin SVM, Kernel methods for non-linearity	

Module 3	**Regression**		1
	LOs: Learners will be able to • Interpret the implications of different error metrics in the context of regression problems. • Identify factors that contribute to overfitting in regression models.	**Module Contents:** • Assessing performance of Regression – Error measures, Overfitting and Underfitting, Catalysts for Overfitting, VC Dimensions • Linear Models: Least Square method, Univariate Regression, Multivariate Linear Regression, Regularized Regression - Ridge Regression and Lasso • Theory of Generalization: Bias and Variance Dilemma, Training and Testing Curves Case Study of Polynomial Curve Fitting.	
Module 4	**LOGIC BASED AND ALGEBRAIC MODELS, TRENDS IN MACHINE LEARNING**		1
	LOs: Learners will be able to • Understand the decision-making process based on the proximity of instances. • Define decision trees and their role in classification and regression. • Understand the process of tree construction and decision-making.	**Module Contents:** • Distance Based Models: Neighbors and Examples, Nearest Neighbor Classification, Distance based clustering algorithms - K-means and K-medoids, Hierarchical clustering. • Rule Based Models: Rule learning for subgroup discovery, Association rules mining – Apriori Algorithm, Confidence and Support parameters. • Tree Based Models: Decision Trees, Minority Class, Impurity Measures – Gini Index and Entropy, Best Split • Ensemble Learning: Combining Multiple	

		Models, Bagging, Randomization, Boosting, Stacking • Reinforcement Learning: Exploration, Exploitation, Rewards, Penalties • Deep Learning: The Neuron, Expressing Linear Perceptron as Neurons, Feed Forward Neural Networks, Linear Neurons and their Limitations, Sigmoid, Tanh and ReLU Neurons	
Assignments/ Activities towards CCE		
	• Conducting training and testing on sample datasets. • Implementing cross-validation techniques for model assessment. • Implementing supervised learning algorithms on labeled datasets. • Exploring unsupervised learning techniques for clustering or dimensionality reduction. • Discussing scenarios where semi-supervised learning is advantageous. • Evaluating classification performance on various datasets. • Discussing and analyzing confusion matrices and ROC curves.	

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SN	Courses, Modules and Outcomes	Course Contents	Cr
	Semester III		
315513	**DATA SCIENCE** **Major (Core) Theory**		**2**
	Course Outcomes: **Learners will be able to:** • Understanding of Data Science Concepts. • Acquire skills in collecting and handling data through various methods, including APIs. • Develop a solid understanding of statistical concepts and terminologies. • Learn the principles and applications of Naive Bayes classification algorithms.		
Module 1	**Introduction to core concepts and technologies, Data collection and management, Data analysis:**		1
	LOs: Learners will be able to • Understand the fundamental concepts and terminologies related to data science. • Understand practical applications of data science across different industries, showcasing real-world scenarios where data science is applied. • Acquire knowledge on collecting data through various methods, with a focus on understanding and using APIs. • Gain an understanding of the Naive Bayes algorithm and its use in probabilistic classification.	**Module Contents:** • Introduction, Terminology, data science process, data science toolkit, Types of data, Example applications. • Introduction, Sources of data, Data collection and APIs, Exploring and fixing data, Data storage and management, Using Multiple data sources. • Introduction, Terminology and concepts, Introduction to statistics, Central tendencies and distributions, Variance, Distribution properties and arithmetic, Samples/CLT. • Basic machine learning algorithms, Line a regression, SVM, Naive Bayes.	
Module 2	**Data visualization and applications:**		1
	LOs: Learners will be able to • Identify and categorize different types of data visualizations. • Understand the technologies and tools used for effective data visualization. • Understand the methods and tools used in developing applications for data science purposes.	**Module Contents:** • Introduction, Types of data visualization, Data for visualization: Data types, Data encodings, Retinal variables, Mapping variables to encodings, Visual encodings. • Applications of Data Science, Technologies for visualization. • Recent trends in various data collection and analysis techniques, various visualization techniques, application development methods of used in data science.	

Assignments/ Activities	
	These assignments aim to apply theoretical concepts to practical application and critical thinking. • Creating a conceptual framework that illustrates the key components of data science, including data collection, processing, analysis, and visualization. • Creating a conceptual framework that illustrates the key components of data science, including data collection, processing, analysis, and visualization. • Organize a workshop where students practice collecting data from different sources, including APIs. • Require them to write a report explaining their findings, including measures of central tendency, variance, and distribution properties. • Discuss the scenarios in which Naive Bayes might be more suitable and encourage critical thinking about algorithm selection.	

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SN	Courses, Modules and Outcomes	Course Contents	Cr
	Semester III		
315524	**Big Data Analytics Lab: Practical Major (Core)**		**2**
	Course Outcomes: **Learners will be able to:** • Optimize business decisions and create competitive advantage with Big Data analytics . • Imparting the architectural concepts of Hadoop and introducing map reduce paradigm. • Derive business benefit from unstructured data. • Introduce programming tools PIG & HIVE in Hadoop echo system. • Developing Big Data applications for streaming data using Apache Spark.		
Module 1	**Exploring Big Data with Hadoop**		1
	LOs: Learners will be able to • Utilize and navigate big data tools and platforms (e.g., Hadoop etc.) for data storage, retrieval, and processing. • Implement distributed computing techniques to handle and analyze massive datasets efficiently. • Proficiency in Apache Hadoop cluster and MapReduce.	**Module Contents:** • Perform setting up and Installing Hadoop in its two operating modes: 1)Pseudo distributed, 2)Fully distributed. • Use web based tools to monitor your Hadoop setup. Implement the following file management tasks in Hadoop: 1)Adding files and directories 2)Retrieving files 3)Deleting files • Benchmark and stress test an Apache Hadoop cluster Run a basic Word Count Map Reduce program to understand Map Reduce Paradigm. 1)Find the number of occurrences of each word appearing in the input file(s) 2)Performing a MapReduce Job for word search count (look for specific keywords in a file) • Stop word elimination problem: 1)Input: A large textual file containing one sentence per line. A small file containing a set of stop words (One stop word per line) 2)Output: A textual file containing the same sentences of the large input file without the words appearing in the small file.	

Module 2	MapReduce Implementation	1

	LOs: Learners will be able to
	
	• Develop MapReduce programs to process and analyze semi-structured, record-oriented data.
	• Implement algorithms to calculate average, maximum, and minimum temperatures for each year in a large dataset using MapReduce.
	• Utilize Pig Latin and Hive to perform various data operations, including sorting, grouping, joining, projecting, and filtering on diverse datasets.
	• Create, alter, and drop databases, tables, views, functions, and indexes in Hive, demonstrating proficiency in managing data structures in a distributed environment.
		Module Contents:
		
		• Write a Map Reduce program that mines weather data. Weather sensors collecting data every hour at many locations across the globe gather large volume of log data, which is a good candidate for analysis with MapReduce, since it is semi structured and record-oriented. Data available at:https://github.com/tomwhite/hadoop-book/tree/master/input/ncdc/all.
		  1) Find average, max and min temperature for each year in NCDC data set?
		  2) Filter the readings of a set based on value of the measurement, Output the line of input files associated with a temperature value greater than 30.0 and store it in a separate file.
		• Purchases.txt Dataset
		  1)Instead of breaking the sales down by store, give us a sales breakdown by product category across all of our stores
		    What is the value of total sales for the following categories?
		     Toys, Consumer Electronics
		  2) Find the monetary value for the highest individual sale for each separate store
		    What are the values for the following stores?
		      Reno, Toledo, Chandler
		  3)Find the total sales value Across all the stores, and the total number of sales.
		• Install and Run Pig then write Pig Latin scripts to sort, group, join, project, and filter your data.
		• Write a Pig Latin scripts for finding TF-IDF value for book dataset (A corpus of eBooks available at: Project Gutenberg)
		• Install and Run Hive then use Hive to create, alter, and drop databases, tables, views, functions,	

		and indexes.	
		• Install, Deploy & configure Apache Spark Cluster. Run apache spark applications using Scala.	
		• Data analytics using Apache Spark on Amazon food dataset, find all the pairs of items frequently reviewed together.	
		• Write a single Spark application that:	
		▪ Transposes the original Amazon food dataset, obtaining a PairRDD of the type:	
		▪ \<user_id\> → \<list of the product_ids reviewed by user_id\>	
		▪ Counts the frequencies of all the pairs of products reviewed together;	
		• Writes on the output folder all the pairs of products that appear more than once and their frequencies. The pairs of products must be sorted by frequency.	

Assignments/ Activities towards Comprehensive Continuous Evaluation	
	• Assign MapReduce programs to analyze provided weather data. Ask them to calculate average, maximum, and minimum temperatures for each year in the dataset.
	• Analyse filter specific readings based on temperature values and store the filtered data into separate files using MapReduce.
	• Illustrate dataset similar to the Purchases.txt dataset. Allocate to write scripts (using tools like Hadoop or Spark) to generate sales breakdowns by product categories across multiple stores.
	• Assign tasks to calculate total sales values for specified product categories and determine the highest individual sale values for distinct stores.
	• Create exercises where students use Pig to perform sorting, grouping, joining, projecting, and filtering operations on sample datasets.
	• Assign exercises where students create, alter, and drop databases, tables, views, functions, and indexes using Hive.

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SN	Courses, Modules and Outcomes	Course Contents	Cr
	Semester III		
325511	BLOCK CHAIN Major (Elective) Theory		3
	Course Outcomes: Learners will be able to: • Understanding of Block Chain Concepts. • Including its decentralized nature, distributed ledger, and cryptographic security features. • Understand the historical context and evolution of blockchain technology, including the development of the first blockchain • Explore the Nakamoto consensus and different consensus algorithms. • Explore the concepts of interoperability and portability in Hyperledger Fabric. • Understand the concept of sharding in blockchain.		
Module 1	Fundamentals of Blockchain		1
	LOs: Learners will be able to • Understand the principles of distributed databases, including their architecture, advantages, and challenges. Learn how to design and manage data across multiple nodes in a network. • Explore the complexities of consensus in distributed systems when some nodes may provide conflicting or malicious information. Understand the significance of Byzantine fault tolerance in distributed systems. • Understand the concept of ASIC resistance in the context of crypto-currencies. Explore the motivations and implications of designing systems to resist mining centralization through specialized hardware. • Gain a comprehensive understanding of cryptography principles, including confidentiality, integrity, and authenticity. Learn the applications and functions of hash functions, digital signatures (specifically ECDSA), memory-hard algorithms, and zero	Module Contents: • Distributed Database, Two General Problem, Byzantine General problem and Fault Tolerance, Hadoop Distributed File System, Distributed Hash Table, ASIC resistance, Turing Complete. • Cryptography: Hash function, Digital Signature - ECDSA, Memory Hard Algorithm, Zero Knowledge Proof.	

	knowledge proofs.		
Module 2	**Blockchain , Distributed Consensus:**		1
	LOs: Learners will be able to • Understand the fundamental concepts of blockchain, including its decentralized nature, distributed ledger, and cryptographic security features. • Gain an understanding of the structure and operation of a blockchain network, including nodes, peers, and the peer-to-peer communication model. • Differentiate between private and public blockchains, understanding their use cases, access control, and levels of decentralization. • Explore the Nakamoto consensus and different consensus algorithms such as Proof of Work, Proof of Stake, and Proof of Burn, understanding their strengths and weaknesses.	**Module Contents:** • Introduction, Advantage over conventional distributed database, Blockchain Network, Mining Mechanism, Distributed Consensus, Merkle Patricia Tree, Gas Limit, Transactions and Fee, Anonymity, Reward, Chain Policy, Life of Blockchain application, Soft & Hard Fork, Private and Public blockchain. • Nakamoto consensus, Proof of Work, Proof of Stake, Proof of Burn, Difficulty Level, Sybil Attack, Energy utilization and alternate.	
Module 3	**Cryptocurrency , Cryptocurrency Regulation:**		1
	LOs: Learners will be able to • Understand the historical context and evolution of blockchain technology, including the development of the first blockchain in the context of Bitcoin. • Explore the construction of the Ethereum blockchain, learn about the Decentralized Autonomous Organization (DAO), and understand the concept and implementation of smart contracts.	**Module Contents:** • History, Distributed Ledger, Bitcoin protocols - Mining strategy and rewards, Ethereum - Construction, DAO, Smart Contract, GHOST, Vulnerability, Attacks, Sidechain, Namecoin. • Stakeholders, Roots of Bit coin, Legal Aspects-Crypto currency Exchange, Black Market and Global Economy. Applications: Internet of Things, Medical Record Management System, Domain Name Service and future of Blockchain.	
Module 4	**Hyperledger , Scalability and other challenges :**		1
	LOs: Learners will be able to • Understand Hyperledger as a blockchain protocol, including its reference architecture, design goals, and the modular approach it adopts.	**Module Contents:** • Hyperledger as a protocol :The reference architecture Requirements and design goals of Hyperledger Fabric: The modular approach	

	• Explore the features of Hyperledger Fabric, such as its modular architecture, privacy and confidentiality mechanisms, scalability considerations, deterministic transactions, and identity management. • Explore the scalability challenges in blockchain networks and understand how Hyperledger Fabric addresses scalability concerns in the network, consensus, storage, and view planes. • Explore the concepts of interoperability and portability in Hyperledger Fabric, understanding how it facilitates integration with other systems and ensures the portability of applications. • Understand the concept of sharding in blockchain networks, and how it enables the parallel processing of transactions to improve scalability.	Privacy and confidentiality, Scalability, Deterministic transactions Identity, Auditability Interoperability Portability Rich data queries Fabric Hyperledger Fabric Membership services Blockchain services Consensus services Distributed ledger ,The peer to peer protocol Ledger storage Chaincode services ,Components of the fabric • Scalability and Other Challenges: Scalability Network plane ,Consensus plane, Storage plane View plane ,Block size increase ,Block interval reduction Invertible Bloom, Lookup Tables Sharding State channels Private blockchain, Proof of Stake Sidechains Subchains Tree chains (trees) Block propagation Bitcoin-NG, Plasma ,Privacy Indistinguishability Obfuscation Homomorphic encryption ,Zero-Knowledge Proofs State channels Secure multiparty computation Usage of hardware to provide confidentiality Coin Join Confidential transactions, Mimble Wimble Security Smart contract security Formal verification and analysis Oyente tool	
Assignments/ Activities		
	These assignments aim to apply theoretical concepts to practical application and critical thinking. • Research and write a comprehensive essay or create a presentation that explains the fundamental concepts of blockchain, highlighting its decentralized nature, the role of a distributed ledger, and the cryptographic security features that contribute to its integrity. • Create a timeline or infographic that visually represents the historical evolution of blockchain technology. Include key milestones, developments, and influential figures in the field. • Write a research paper or prepare a presentation that delves into the concepts of interoperability and portability within Hyperledger Fabric. • Design a workshop or hands-on exercise where participants simulate the sharding process in a blockchain network. Document the findings and insights.	

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SN	Courses, Modules and Outcomes	Course Contents	Cr
	Semester III		
325512	**GIS AND REMOTE SENSING** **Major(Elective) Theory**		**4**
	Course Outcomes: **Learners will be able to:** • Understanding Fundamentals, Technical Skills, Data Acquisition and Management. • Spatial Analysis, Mapping and Visualization, Remote Sensing Applications, Integration of Technologies • Problem Solving, Communication Skills**.**		
Module 1	**Fundamentals of GIS**		1
	LOs: Learners will be able to • Define GIS (Geographic Information System), Understand Components of GIS, Comprehend Spatial Data, Understand Characteristics of Spatial Data • Analyze Spatial Data Maps, Attribute Data Management - Database Data Model, GIS Applications, Developments in Database for GIS.	**Module Contents:** • Defining GIS, components of GIS, spatial data, spatial data-maps, characteristics, spatial data modeling, attribute data management- database data model, GIS applications and developments in database.	
Module 2	**Input-Output and Data Analysis in GIS**		1
	LOs: Learners will be able to • Data Input and Editing, Data Analysis • Analytical Modeling in GIS, Output from GIS.	**Module Contents:** • Data input and editing– methods, editing, integration, Data analysis-measurements, queries, reclassification, buffering, map overlay, interpolation, analysis of surfaces, network analysis, spatial analysis, Analytical modeling in GIS-physical, environment and human processes, output from GIS – maps, non-cartographic output, spatial multimedia, decision support.	
Module 3	**Issues in GIS:**		1
	LOs: Learners will be able to • Development of Computer Methods, Human and Organizational Issues in GIS, GIS Data Quality and Error Analysis, GIS Project Design	**Module Contents:** • Development of computer methods for spatial data, Issues in GIS- data quality and errors, sources of errors, human and organizational	

		issues, GIS project design and management–problem identification, designing a data model, project management, Implementation, evaluation, the future of GIS, Internet resources of GIS.	
	and Management • Project Implementation and Evaluation, Understanding the Future of GIS, Internet Resources for GIS, Communication Skills.		
Module 4	Remote Sensing, Global Positioning Systems (GPS)		1
	LOs: Learners will be able to • Principles of Remote Sensing, Remote Sensing System Classification, Imaging Characteristics, Extraction of Information from Images, Integration of Remote Sensing and GIS • Introduction to GPS, Accuracy of GPS, Differential GPS, Applications of GPS, Integration of GIS and GPS.	**Module Contents:** • Principles of remote sensing, remote sensing system-classification, Imaging, characteristics, extraction of information from images–metric and thematic, Integration of RS and GIS. • Introduction to GPS, Accuracy of GPS, Differential GPS, Applications of GPS, Integration of GIS and GPS.	
Assignments/ Activities			
	These assignments aim to apply theoretical concepts to practical application and critical thinking. • Discuss the importance of metadata in data warehousing, to create a metadata management plan for a given data warehouse, outlining how metadata will be collected, stored, and utilized. • From a dataset extract relevant information, transform it according to a predefined business rule, and load it into a data warehouse. • Create a set of business queries related to a hypothetical business problem • Find a dataset suitable for clustering analysis. then use clustering algorithms to identify natural groupings within the data and interpret the results. • web mining project (perform web scraping, and apply web mining techniques)		

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SN	Courses, Modules and Outcomes	Course Contents	Cr
	Semester III		
325513	**Software Testing** **Major (Elective) Theory**		**4**
	Course Outcomes: **Learners will be able to:** • Understand the fundamental principles and concepts of software testing, including its purpose, objectives, and the role it plays in software development. • Proficient in various test design techniques, including equivalence partitioning, boundary value analysis, decision tables, and state transition testing, enabling them to create effective test cases. • Apply various testing methods such as functional, non-functional, unit, integration, system, regression, and acceptance testing to diverse software systems. • Understand quality assurance principles and best practices, emphasizing the importance of testing in the software development lifecycle. • Understand the ethical and professional responsibilities associated with software testing.		
Module 1	**Overview of Software Testing**		1
	LOs: Learners will be able to • Gain proficiency in software testing terminologies, methodologies, and life cycles. • Comprehend the economic aspects of testing and its impact on organizational structures. • Develop skills in creating policies, test strategies, and risk management to ensure meeting customer needs. • Analyze the advantages of structured testing processes and their cost implications. • Demonstrate proficiency in the seven-step software testing process.	**Module Contents:** • Software Testing Terminology and Methodology Software Testing Terminology, Software Testing Life Cycle, Writing a Policy for Software Testing, Economics of Testing, Testing – An organizational Issue, Management Support for Software Testing, Fig. of Software Testing Methodology, Risk associated with not meeting customer needs, Developing Test Strategy • Overview of Software Testing Process Advantages of Following a Process, The Cost of Computer Testing, The Seven-Step Software Testing Process • Verification and Validation Verification and Validation (V&V) Activities, Verification, Verification of Requirements, Verification of High –level Design, Verification of Low – level Design, How to Verify Code? ,Validation	

		• Static Testing Inspections, Structured Walkthroughs, Technical Reviews.	
Module 2	**Validation and Regression Testing**		1
	LOs: Learners will be able to • Execute various validation activities including unit, integration, function, system, and acceptance testing to assess different aspects of software functionality and ensure its compliance with requirements. • Differentiate between progressive and regressive testing, comprehending the significance of regression testing in maintaining software quality. • Apply regression testing techniques to identify potential issues arising from software changes or updates, thereby ensuring the stability and reliability of the software product. • Identify the objectives of regression testing and determine appropriate instances for conducting regression tests in the software development life cycle. • Define regression test problems, select suitable types of regression testing, and utilize effective regression testing strategies to address software changes and minimize the risk of introducing new defects into the system.	**Module Contents:** • Validation Activities Unit Validation Testing, Integration Testing, Function Testing, System Testing , Acceptance Testing • Regression Testing Progressive vs. Regressive Testing, Regression Testing Produces Quality Software, Regression Testability, Objectives of Regression Testing, When is Regression Testing Done? , Regression Testing Types, Defining Regression Test Problem, Regression Testing Techniques.	
Module 3	**Testing Management and Metrics**		1
	LOs: • Establish a comprehensive understanding of test management structures, including the organization and composition of testing groups, enabling effective test planning and detailed	**Module Contents:** • Test Management Test Organization, Structure of Testing Group, Test Planning, Detailed Test Design and Test Specifications • Software Metrics Need for Software Management, Definition of Software Metrics, Classification	

		test design. • Recognize the need for software metrics and demonstrate the ability to define, classify, and apply various metrics within the software development life cycle. • Evaluate entities to be measured within software projects, particularly focusing on size metrics and their implications on software management. • Formulate measurement objectives specific to testing, identifying attributes and corresponding metrics relevant to monitoring and controlling the testing process.	of Software Metrics, Entities to be Measured, Size Metrics • Testing Metrics for Monitoring and Controlling the Testing Process Measurement Objectives for Testing, Attributes and Corresponding Metrics in Software Testing, Attributes, Estimation Models for Estimating Testing Efforts (include only topic Halstead Metrics), Test Point Analysis (TPA) – introduction only.	
Module 4	**Automation Testing Tool**			1
	LOs: Learners will be able to • Evaluate the necessity and significance of test process maturity, demonstrating the ability to measure, assess, and improve test processes within an organization using established maturity models. • Identify the rationale behind automation in testing, categorize various testing tools, and apply criteria for selecting appropriate tools while considering associated costs. • Analyze guidelines for automated testing and gain an overview of commercial testing tools, fostering the skills required for implementing automated testing effectively. • Apply agile methodologies to enhance software testing, recognizing the importance of agility, overcoming inhibitors, and implementing solutions to improve testing processes within an agile framework.	**Module Contents:** • Testing Process Maturity Models Need for Test Process Maturity, Measurement and Improvement of a Test Process, Test Process Maturity Models • Automation and Testing Tools Need for Automation, Categorization of Testing Tools, Selection of Testing Tools, Cost Incurred in Testing Tools, Guidelines for Automated Testing, Overview of Some Commercial Testing Tools Testing Object Oriented Software Object-Oriented Testing • Using Agile Methods to Improve Software Testing The importance of Agility, Building an Agile Testing Process, Agility Inhibitors, Is Improvement Necessary, Compressing Time, Challenges, Solutions , Measuring Readiness , The Seven-Step Process 4.5 Test Plan.	

Assignments/ Activities towards CCE	
- Provide a case study of an organization's testing process and have students analyze and propose improvements based on maturity model principles. - Organize a session where students demonstrate how a specific testing tool works, highlighting its features, benefits, and practical applications. - Conduct a simulation where students participate in an agile testing environment, taking on roles (developer, tester, product owner) to experience iterative development, testing, and feedback cycles. - Provide a software scenario and ask students to create a comprehensive test plan, including test objectives, strategies, resource allocation, and metrics for evaluating test progress. - Divide students into teams, assigning each team a different validation testing type (e.g., unit, integration). They role-play scenarios to validate a software component or system.	

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SN	Courses, Modules and Outcomes	Course Contents	Cr
	Semester III		
325514	**Robotic Process Automation** **Major(Elective) Theory**		**4**
	Course Outcomes: **Learners will be able to:** • Define and explain the fundamental concepts and principles of Robotic Process Automation. • Gain proficiency in using popular RPA tools such as UiPath, Automation Anywhere, or Blue Prism. • Develop RPA bots to automate specific tasks and processes. • Diagnose and troubleshoot common issues encountered during RPA implementation.		
Module 1	**Robotic Process Automation Foundations, UiPath, Automation Anywhere**		1
	LOs: Learners will be able to • Understanding RPA Fundamentals, RPA Capabilities and Components, Benefits and Downsides of RPA, Comparison with Other Business Technologies. • Comparison with Other Business Technologies, Automation Anywhere Overview.	**Module Contents:** • What is RPA, Flavors of RPA, History of RPA, What can RPA do, Components of RPA, The Benefits of RPA, The Downsides of RPA, RPA Compared to BPO, BPM, BPA, What is the Difference Between AI and RPA, RPA Tools and Platforms, Consumer Willingness for Automation, The Workforce of the Future • What is UiPath, UiPath Studio, UiPath Robot, UiPath Orchestrator, UiPath – an integrated view • What is Automation Anywhere, Enterprise Control Room, IQ Bot.	
Module 2	**Downloading and Installing UiPath Studio and Data Manipulation**		1
	LOs: Learners will be able to • UiPath Studio and Task Recorder Proficiency, Workflow Sequencing and Control Flow. • Variables, Scope, and Collections, Arguments, Clipboard Management. • Data Table Usage, File Operations, CSV/Excel Handling.	**Module Contents:** • Learning UiPath Studio, Task Recorder, Step by step examples using the recorder • Sequencing the workflow, Activities, Control flow, various types of loops, and decision making, Step by step example using Sequence, Flowchart and Control Flow, Log Message. • Variables and scope, Collections, Arguments – purpose and use, Data table usage with examples, Clipboard management, File operation with step-by-step example, CSV/Excel to data	

		table and vice versa.	
Module 3	**Taking Control of the Controls, Exception Handling and Debugging**		1
	LOs: Learners will be able to • UI Automation Basics, Advanced Automation Plugins • Assistant Bots and Triggers. • Error Handling and Debugging	**Module Contents:** • Finding and attaching windows, Finding the control, Techniques for waiting for a control, Act on controls – mouse and keyboard activities, Working with UiExplorer, Handling events, Revisit recorder, Screen Scraping, When to use OCR, Types of OCR available, Avoiding typical failure points • Terminal plugin, SAP automation, Java plugin, Citrix automation, Mail plugin, PDF plugin, Web integration, Excel and Word plugins, Credential management, Extensions – Java, Chrome, Firefox and Silverlight • What are assistant bots, Monitoring system event triggers, Monitoring image and element triggers, Launching an assistant bot on a keyboard event. • Exception handling, Common exceptions and ways to handle them, Logging and taking screenshots, Debugging techniques, Collecting crash dumps, Error reporting	
Module 4	**Managing and Maintaining the Code.**		1
	LOs: Learners will be able to • Updates, Project Organization, • Reusability of Workflows, State Machine. • Using Config Files and Examples of a Config File, Using Orchestration Server to Control Bots, Publishing and Managing.	**Module Contents:** • Updates Project organization, Nesting workflows, Reusability of workflows, Commenting techniques, State Machine, When to use Flowcharts, State Machines or Sequences, Using config files and examples of a config file, Integrating a TFS Server • Publishing using publish utility, Overview of Orchestration Server, Using Orchestration Server to Control bots, Using	

		Orchestration server to deploy bots, License management, Publishing and managing	
Assignments/ Activities			
	These assignments aim to apply theoretical concepts to practical application and critical thinking. • Discuss the importance of metadata in data warehousing, to create a metadata management plan for a given data warehouse, outlining how metadata will be collected, stored, and utilized. • From a dataset extract relevant information, transform it according to a predefined business rule, and load it into a data warehouse. • Create a set of business queries related to a hypothetical business problem • Find a dataset suitable for clustering analysis. then use clustering algorithms to identify natural groupings within the data and interpret the results. • web mining project (perform web scraping, and apply web mining techniques)		

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SN	Courses, Modules and Outcomes	Course Contents	Cr
	Semester IV		
415511	**Deep Learning** **Major(Core) Theory**		**4**
	Course Outcomes: **Learners will be able to:** • Demonstrate the ability to implement a perceptron, understanding the input features, weights, bias, and the activation function. • Understanding Deep Learning, Activation Functions, Forward Propagation • Explore convolution operations, including padding, stride, and batch processing. Implement a convolution layer and a pooling layer in TensorFlow • Explore different RNN architectures, including one-to-one, one-to-many, many-to-one, and many-to-many. Implement and train RNNs. • Understand various types of autoencoders, including standard, sparse, denoising, contractive, and variational autoencoders.		
Module 1	**Introduction to Deep Learning**		1
	LOs: Learners will be able to • Understanding how to build a perceptron involves defining the input features, weights, bias, and the activation function. • Discussing the limitations of a single-layer perceptron, such as its inability to learn non-linear relationships. • Description of the structure of artificial neural networks, including input layer, hidden layers, and output layer. • Overview of activation functions that introduce non-linearity, enabling neural networks to learn complex patterns.	**Module Contents:** • Perceptron: What is a Perceptron? Implementing perceptron, Introducing & Implementing Weights & Bias, Multilayer Perceptron, Limitations of perceptron. • Introduction to Deep Learning: What is deep learning? Biological and artificial neurons, ANN and its layers, Input layer, Hidden layer, Output layer, exploring activation functions, the sigmoid function, the tanh function, The Rectified Linear Unit function, The leaky ReLU function, The Swish function, The softmax function, Forward propagation in ANN, How does ANN learn?	
Module 2	**Convolutional Neural Networks:**		1
	LOs: Learners will be able to • Analyse how TensorFlow represents computations as directed acyclic graphs (DAGs). • Understanding the concept of sessions for executing operations in a TensorFlow graph. • Analyse General architecture of CNN Comprising convolutional layers, pooling layers, and fully connected layers • Implementing a Convolution Layer, Pooling Layer	**Module Contents:** • Getting to Know TensorFlow • What is TensorFlow? Understanding computational graphs and sessions, Sessions, Variables, constants, and placeholders, Introducing TensorBoard, Creating a name scope. • Back propagation Algorithm, Neural Network Training, • Convolutional Neural Networks: • Overall Architecture, The Convolution Layer, Issues with the Fully Connected Layer, Convolution Operations, Padding, Stride, Batch	

		Processing, The Pooling Layer, Implementing a Convolution Layer, Implementing a Pooling Layer, Implementing a CNN, Visualizing a CNN.	
Module 3	**Optimizers in DL**		1
	LOs: Learners will be able to • Understanding the basic concept of gradient descent as an optimization algorithm for minimizing the loss function during training • Introduction to adaptive learning rates based on the historical gradients of parameters. • Understanding the challenges of training RNNs and the need for handling sequential dependencies. • Explanation of backpropagation through time, the algorithm used to train RNNs by unfolding them into a computational graph over time. • Different type of RNNarchitectures	**Module Contents:** • Optimizers in DL: Gradient Descent, Stochastic Gradient Descent, Mini-Batch Gradient Descent, SGD with Momentum, AdaGrad (Adaptive Gradient Descent), RMS-Prop (Root Mean Square Propagation), AdaDelta, Adam (Adaptive Moment Estimation). • Introducing RNNs: • RNN implementation and training, Backpropagation through time, Vanishing & exploding gradients, long short-term memory LSTM, • Different types of RNN architectures: • One-to-one architecture • One-to-many architecture • Many-to-one architecture • Many-to-many architecture.	
Module 4	**Deep Unsupervised Learning**		1
	LOs: Learners will be able to • Understanding autoencoders as neural network architectures designed for unsupervised learning by encoding and decoding input data. • Generative Adversarial Networks (GANs) as a framework for training generative models through adversarial training. • Understanding scenarios of different models	**Module Contents:** • Deep Unsupervised Learning: Auto encoders (standard, sparse, denoising, contractive, etc), Variational Auto encoders, • Deep Generative Models GANS.	
Assignments/ Activities			
	These assignments aim to apply theoretical concepts to practical application and critical thinking. • Task students to build a simple neural network from scratch using Python or a framework like TensorFlow/Keras. They should train it on a dataset and analyze its performance. • Provide pre-trained neural network models and have students visualize the learned features and activations at different layers to understand how information is processed. • Assign students to create a CNN model for image classification using a dataset like CIFAR-10 or MNIST. They should experiment with different		

| | architectures and hyper parameters.
 • Challenge students to create a GAN model capable of generating realistic images from a given dataset (e.g., faces, digits). They should evaluate the quality of generated images | |

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SN	Courses, Modules and Outcomes	Course Contents	Cr
	Semester IV		
415512	**NATURAL LANGUAGE PROCESSING** **Major (Core) Theory**		4
	Course Outcomes: **Learners will be able to:** • Understand different building blocks of NLP • Design algorithms for NLP problems. • Understand machine translation and its techniques • Learn and use different tools for NLP.		
Module 1	**Introduction**		1
	LOs: Learners will be able to • Define the significance and necessity of natural language processing (NLP) in modern computing and communication systems. • Differentiate between various levels of language processing (phonetics, syntax, semantics) and comprehend their role in NLP. • Identify and analyze the key issues, challenges, and limitations in natural language processing. • Analyze and discuss diverse applications of NLP across various domains such as machine translation, sentiment analysis, information retrieval, chatbots, and more.	**Module Contents:** • Need for processing of natural languages, Language processing levels, Issues and challenges in NLP, History, Classical approaches to NLP with knowledge bases and linguistic rules. Introduction to formal languages, finite state automata and regular expressions. • Applications of NLP.	
Module 2	**Morphology and Phonology**		1
	LOs: Learners will be able to • Define and differentiate between inflectional and derivational morphology, recognizing their significance in understanding word formation and structure. • Explain the fundamentals of phonetics, including phonemes and phonological rules, to analyze the sound	**Module Contents:** • Morphology fundamentals, Inflectional and Derivational morphology, Morphological parsing, Finite State transducers, N- gram language models, phonetics fundamentals, phoneme and phonological rules, machine learning of phonology, phonological aspects of prosody and speech synthesis.	

	structure of languages.		
Module 3	**Part-of-Speech Tagging and Parsing:**		1
	LOs: Learners will be able to • Define and categorize word classes, recognizing their significance in linguistic analysis and natural language understanding. • Analyse basic parsing strategies such as top-down and bottom-up parsing, recognizing their advantages and limitations in syntactic analysis. • Demonstrate an understanding of finite state parsing methods, applying them to analyse and process sequential structures in language.	**Module Contents:** • Word Classes, Part of speech tagging, Tagsets, Rule based, Stochastic and Transformation based POS tagging. Basic parsing strategies, top-down parsing, bottom up parsing, parsing with context free grammars, a basic top down parser, Earley parser, CYK parser, Finite state parsing methods, Unification of feature structures.	
Module 4	**Semantic Analysis and Pragmatics:**		1
	LOs: Learners will be able to • Define and differentiate between lexemes, understanding their internal structures and the relationships among different senses of words. • Demonstrate proficiency in word sense disambiguation techniques, employing computational methods to determine the correct meaning of words within a given context. • Apply lexical semantic analysis techniques and WordNet in computational models for tasks such as information retrieval, text summarization, and sentiment analysis.	**Module Contents:** • Lexical Semantics, Lexemes, Relations among lexemes and their senses, WordNet, Internal structure of words, metaphor and metonymy & their computational approaches, Word Sense Disambiguation. • Discourse, Reference resolution, syntactic and semantic constraints on coreference, pronoun resolution reference, text coherence, discourse structure, Dialogue- Acts, structure, conversational agents, Introduction to language generation, architecture, discourse planning.	
Assignments/ Activities			
	These assignments aim to apply theoretical concepts to practical application and critical thinking: • Organize a workshop where students collaboratively annotate a text corpus with POS tags, discussing ambiguities and challenging cases.		

| | • Task students to build and evaluate a part-of-speech tagging system using a dataset. They should measure accuracy, precision, and recall of their model.
• Assign students to create an NER system to identify entities (e.g., persons, organizations) in text data, assessing its precision and recall.
• Task students to perform sentiment analysis on social media posts or reviews, identifying sentiments and evaluating the effectiveness of the analysis.
• Assign groups to explore and compare different machine translation systems, evaluating their translations and discussing strengths and weaknesses.
• Task students to build a text generation model (e.g., using recurrent neural networks) and generate coherent text based on a given prompt or theme.
• Provide case studies involving ethical issues in NLP and ask students to analyze and propose solutions considering ethical considerations. | |

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SN	Courses, Modules and Outcomes	Course Contents	Cr
	Semester IV		
415513	**Mobile Application Development using Android Programming: Practical** **Major (Core)**		**2**
	Course Outcomes: **Learners will be able to:** • Demonstrate knowledge of the Android platform architecture. • Set up the Android development environment, including the Android Studio IDE. • Write and understand Java code relevant to Android app development. • Implement object-oriented programming concepts in Android applications. • Implement responsive and adaptive layouts for different screen sizes and orientations. • Create and manage activities as the building blocks of Android applications. • Utilize intents to enable communication between different components of an Android app.		
Module 1	**Fundamentals of Android Development**		1
	LOs: Learners will be able to • Define what Android is and explain its evolution through different versions. • List the system requirements for setting up the Android Development Environment. • Analyse the directory structure of an Android project. • Describe the role of XML in Android application development. • Develop a basic Android application using the Android Studio IDE. • Define Android application components and their roles. • Understand the role of Android Services in processing tasks in the background. • Describe the role of Content Providers in Android for data	**Module Contents:** • What is Android, Android versions and its feature set The various Android devices on the market, The Android Market application store, Android Development Environment-System Requirements, Creating Android Virtual Devices (AVDs) • Android Software Development Platform, The Directory Structure of an Android Project , Common Default Resources Folders, The Values Folder, Leveraging Android XML, Screen Sizes , Launching Your Application: The Android Manifest.xml File, Creating Your First Android Application • Android Application Components, Android Activities: Defining the UI, Android Services: Processing in the Background, Broadcast Receivers: Announcements and Notifications Content Providers: Data Management, Android Intent Objects: Messaging for Components.	

		management.		
Module 2	**Android Manifest XML**			1
	LOs: Learners will be able to • Declare Android components in the Manifest XML file. • Design user interfaces for different Android devices. • Utilize Views, View Groups, and Android Layout Managers for effective UI design. • Retrieve data from users through various input mechanisms. • Implement buttons, check boxes, and radio groups in user interfaces. • Utilize Gallery, Image Switcher, GridView, and ImageView views for image display. • Explore multithreading in Android, including the main application thread and creating new threads. • Explore sending and receiving emails programmatically. • Configure the Android Emulator for simulating location-based services. • Play audio and video in Android applications. • Record audio and video using the device. • Utilize the camera to take and process pictures within the application.	**Module Contents:** • Android Manifest XML: Declaring Your Components, Designing for Different Android Devices, Views and View Groups, Android Layout Managers, The View Hierarchy, Designing an Android User Interface using the Graphical Layout Tool • Displaying Text with Text View, Retrieving Data from Users, Using Buttons, Check Boxes and Radio Groups, Getting Dates and Times from Users, Using Indicators to Display Data to Users, Adjusting Progress with Seek Bar, Working with Menus usingviews, Gallery, Image Switcher, GridView, and ImageView views to displayimages, Creating Animation • Intent Overview, Implicit Intents, Creating the Implicit Intent Example Project, Explicit Intents, Creating the Explicit Intent Example Application, Intents with Activities, Intents with Broadcast Receivers, An Overview of Threads, The Application Main Thread, Thread Handlers, A Basic Threading Example, Creating a New Thread, Implementing a Thread Handler, Passing a Message to the Handler. • Sending SMS Messages Programmatically, Getting Feedback after Sending the Message Sending SMS Messages Using Intent Receiving, sending email, Introduction to location-based service, configuring the Android Emulator for Location-Based Services, Map-Based Activities • Playing Audio and Video, Recording Audio andVideo, Using the Camera to Take and Process Pictures.	
Assignments/ Activities towards Comprehensive Continuous Evaluation				
	These assignments aim to apply theoretical concepts to practical application and critical thinking:			

- Introduce students to the Android Studio IDE, project structure, and the basic components of an Android app.
- Practice using XML for UI layout, understanding Views and View Groups, and exploring the Graphical Layout Tool.
- Implement multimedia features, work with MediaPlayer, and understand handling different media formats.
- Understand the concept of intents, explore data passing between activities, and use both types of intents.
- Integrate location-based services, use maps, and handle user input for reminder details.
- Understand threading in Android, work with background processing, and implement thread handlers.
- Develop an app that captures images using the device camera and allows users to apply basic filters.
- Prepare and publish a simple app on the Google Play Store.

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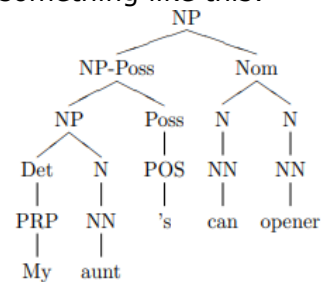
SN	Courses, Modules and Outcomes	Course Contents	Cr
	Semester IV		
415524	**Natural Language Processing Lab: Practical Major (Core)**		**2**
	Course Outcomes: **Learners will be able to:** • Understand and implement the basics of Natural Language Processing • Understand different building blocks of NLP. • Design algorithms for NLP problems. • Understand machine translation and its techniques. • Learn and use different tools for NLP. • To implement NLP task like Names Entity Recognition, Syntactic and Semantic analysis and WordSense disambiguation.		
Module 1	**POS Tagging and Name Entity Recognition**		1
	LOs: Learners will be able to • Identify and tokenize words in sentences. • Assign accurate part-of-speech (POS) tags to each token. • Understand and apply POS tagging rules for different types of words (nouns, verbs, adjectives, etc.). • Construct phrase-structure trees (PSTs) for each identified noun phrase. • Analyze the distributional properties of constituents and invent labels for non-terminals based on linguistic analysis. • Apply named entity recognition (NER) techniques to extract relevant information from text. • Evaluate the importance of named entities in understanding the content and context of a document. • Apply natural language processing (NLP) concepts to real-world tasks, enhancing skills in information extraction	**Module Contents:** • <u>Experiment 1:</u> Part-of-Speech Tagging Choose 2 sentences from each of the 3 sets below (6 total) and assign part-of-speech (POS) tags to each token of each sentence. Sentences : (1) a. The old car broke down in the car park b. At least two men broke in and stole my TV c. The horses were broken in and ridden in two weeks d Kim and Sandy both broke up with their partners (2) a. The horse which Kim sometimes rides is more bad tempered than mine b. The horse as well as the rabbits which we wanted to eat has escaped c. It was my aunt's car which we sold at auction last year in February d. The only rabbit that I ever liked was eaten by my parents one summer e. The veterans who I thought that we would meet at the reunion were dead (3) a. Natural disasters – storms, flooding, hurricanes – occur infrequently but cause devastation that strains resources to breaking point b. Letters delivered on time by old-fashioned means are	

and document analysis.	increasingly rare, so it is as well that that is not the only option available c. It won't rain but there might be snow on high ground if the temperature stays about the same over the next 24 hours d. The long and lonely road to redemption begins with self-reflection: the need to delve inwards to deconstruct layers of psychological obfuscation e. My wildest dream is to build a POS tagger which processes 10K words per second and uses only 1MB of RAM, but it may prove too hard ● Experiment 2: Task phrase-structure tree (PST) Choose 2 sentences from sets below (4 total) and bracket all the noun phrases (NPs) in each sentence. Then for each NP found, draw a phrase-structure tree (PST) using non-terminal labels (NP, AP etc.) You can invent your own labels for constituents motivated by distributional analysis as necessary, and base your PST on the tokenization and PoS tags assigned in the first handout. For instance the PST analysis of the first two NPs in: My aunt's can opener can open a drum should look something like this: Sentences (1) a. The old car broke down in the car park b. At least two men broke in and stole my TV c. The horses were broken in and ridden in two weeks d. Kim and Sandy both broke up with their partners (2) a. The horse which Kim sometimes rides is worse tempered than mine b. The horse as well as the	

		rabbits which we wanted to eat have escaped c. It was my aunt's car which we sold at auction last year in February d. The only rabbit that I ever liked was eaten by my parents one summer e. The veterans who I thought that we would meet at the reunion were dead • <u>Experiment 3:</u> Named entity recognition (NER), Identifying person, location, and organization names in a given document	
Module 2	**Syntactic and Semantic Analysis**		1
	LOs: Learners will be able to • Construct syntactic trees for sentences in the document. • Identify sentence boundaries, phrases, and grammatical structures. • Construct syntactic trees for sentences in the document. • Apply dependency parsing techniques to represent the syntactic relationships between words. • Analyse the syntactic complexity of sentences in terms of structure and depth. • Identify and label semantic roles of words and phrases in a given document. • Demonstrate an understanding of WordNet and its structure.	**Module Contents:** • <u>Experiment 4:</u> Syntactic analysis of a given document • <u>Experiment 5:</u> Semantic analysis of a given document • <u>Experiment 6:</u> To implement word Sense Disambiguation for a specific scenario using wordnet.	
Assignments/ Activities towards Comprehensive Continuous Evaluation		
	These assignments aim to apply theoretical concepts to practical application and critical thinking: • Gain hands-on experience with text pre-processing techniques in natural language processing (NLP). • Understand the importance of tokenization in NLP. • Select a dataset containing textual information (e.g., reviews, articles, tweets). • Perform text preprocessing tasks • Apply named entity recognition techniques to extract entities from a given text. • Apply named entity recognition techniques to extract entities from a given text. • Develop a sentiment analysis model to classify text into positive, negative, or neutral sentiments.		

	• Understand the application of machine learning in sentiment analysis. • Develop a text classification model to categorize documents into predefined classes. • Explore different classification algorithms in NLP.	

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SN	Courses, Modules and Outcomes	Course Contents	Cr
	Semester IV		
425511	**Information Security Major(Elective) Theory**		**4**
	Course Outcomes: **Learners will be able to:** • Understand the services and mechanisms provided by symmetric ciphers. • Analyse the OSI Security Architecture and its relevance to information security. • Describe classical encryption techniques within the symmetric cipher model. • Explain the principles of public key cryptography. • Understand digital signatures. • Explore authentication applications, including Kerberos and X.500 Authentication Service. • Analyse malicious software, including viruses and related threats, and countermeasures		
Module 1	**Symmetric Ciphers**		1
	LOs: Learners will be able to • Explain the fundamental services provided by symmetric ciphers. • Identify and defend against common attacks on symmetric ciphers. • Analyze the OSI Security Architecture and its role in network security. • Describe classical encryption techniques, including substitution and transposition. • Understand the principles of block ciphers, focusing on the Data Encryption Standard (DES). • Evaluate the strength and weaknesses of DES through differential and linear cryptanalysis. • Apply block cipher design principles to create secure encryption algorithms. • Explain different modes of operation used by block ciphers for secure communication.	**Module Contents:** • **Overview** – Services, Mechanism and Attacks, The OSI Security. Architecture, A model for network security Classical Encryption techniques – Symmetric Cipher model, Substitution. Techniques, Transposition techniques, Rotor Machines, Steganography. Block Cipher and Data Encryption Standard – Simplified DES, Block. Chiper principles, The Data Encryption Standard, The strength of DES, Differential and Linear Cryptanalysis, Block Cipher design principles, Block Cipher mode of Operation	
Module 2	**Asymmetric Ciphers**		1
	LOs: Learners will be able to • Understand the principles of public key cryptography and its applications. • Explain the RSA algorithm, including key management	**Module Contents:** • Public Key Cryptography and RSA – Principles of Public Key Cryptosystems, The RSA Algorithm Key management ; Other public key cryptosystemsKey	

	practices. • Compare different public key cryptosystems and assess their strengths and weaknesses. • Describe the principles and applications of Diffie-Hellman key exchange and elliptical curve cryptography. • Discuss authentication requirements and functions in secure communication. • Explain the principles of message authentication codes and secure hash functions. • Understand the role of digital signatures and authentication protocols in information security.	Management, Diffe-Hellman Key Exchange, Elliptical Curve Arithmetic, Elliptical curve Cryptography Message Authentication and HASH Functions – Authentication requirements, Authentication Functions, Message Authentication Codes, Hash Functions, security of Hash Functions and MACS Digital Signatures and Authentication Protocols – Digital Signatures, Authentication Protocols, Digital Signature Standard	
Module 3	**Network Security practice**		1
	LOs: Learners will be able to • Implement and configure authentication protocols such as Kerberos and X.500. • Utilize Pretty Good Privacy (PGP) and S/MIME for secure email communication. • Understand the architecture and components of IP Security (IPSec). • Implement IPSec components, including Authentication Header (AH) and Encapsulating Security Payload (ESP). • Demonstrate proficiency in combining Security Associations and key management in IPSec. • Identify and mitigate web security threats and vulnerabilities. • Implement SSL/TLS protocols for securing web communication. • Understand the principles and applications of Secure Electronic Transaction (SET) in e-commerce.	**Module Contents:** • **Network Security practice** : Authentication Applications – Kerberos, X.500 Authentication Service Electronic Mail Security – Pretty Good Privacy, S/MIME IP Security – IP Security Overview, IP Security Architecture, Authentication Header, Encapsulating security payload, Combining Security Associations, Key Management WEB Security – Web Security Considerations, Secure Socket Layer and Transport Layer Security, Secure Electronic Transaction	
Module 4	**System Security**		1
	LOs: Learners will be able to • Implement and configure intrusion detection systems for proactive threat identification. • Design and enforce effective password management policies and practices. • Implement countermeasures against viruses and related threats.	**Module Contents:** • System Security : Intruders – Intruders, Intruder detection, Password Management, Malicious Software – Viruses and Related Threats, Virus Countermeasures, Firewall design principles, Trusted system.	

	• Design and configure firewalls based on security requirements. • Understand and implement different types of firewalls for network security. • Recognize the concept of trusted systems and implement mechanisms to build and maintain trust in computing environments	
Assignments/ Activities		
	These assignments aim to apply theoretical concepts to practical application and critical thinking. • In groups, analyse the case studies to identify the type of malware involved, the attack vectors, and the impact on the affected systems. • Set up a simulated network environment with a variety of devices and services. • Research and identify characteristics that contribute to the trustworthiness of a computing system. • Apply the checklist to evaluate a given computing environment and provide recommendations for enhancing trust. • In pairs or small groups, task students with configuring a firewall to secure the network	

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SN	Courses, Modules and Outcomes	Course Contents	Cr
	Semester IV		
425512	**Digital Forensics** **Major (Elective) Theory**		**4**
	Course Outcomes: **Learners will be able to:** • Understand the need of digital forensics. • Acquire different methodologies for incident response. • Grasp the knowledge of forensic duplication and implement it. • Evaluate the forensic analysis in file system and its fundamentals. • Understand the different attacks in network system and way to analysis its. • Illustrate the analysis techniques by investigate live system. • Acquire knowledge of Cyber law. • Proficient in different hacker tools.		
Module 1	**Introduction to Digital Forensics**		1
	LOs: Learners will be able to • Understand and define basic concepts of Cybercrime. • Illustrate different types of cybercrime and differentiate it. • Grasp the fundamental concepts of Digital Forensics. • Aware about Incident and incident response methodology. • Analyse the process after detection of incident.	**Module Contents:** • Introduction of Cybercrime: Types, The Internet spawns crime, Worms versus viruses, Computers' roles in crimes, Introduction to digital forensics, Introduction to Incident - Incident Response Methodology – Steps - Activities in Initial Response, Phase after detection of an incident.	
Module 2	**Initial Response and forensic duplication**		1
	LOs: Learners will be able to • Synthesized the concept of initial response. • Understand core concepts of Forensic duplication. • Analyse the tools for forensic duplicates. • Demonstrate forensic duplicate of hard drive.	**Module Contents:** • Initial Response & Volatile Data Collection from Windows system - Initial Response & Volatile Data Collection from Unix system – Forensic Duplication: Forensic duplication: Forensic Duplicates as Admissible Evidence, Forensic Duplication Tool Requirements, Creating a Forensic Duplicate/Qualified Forensic Duplicate of a Hard Drive.	

Module 3	Preserving ,Recovering Digital Evidence and Network forensic		1
	LOs:	**Module Contents:**	
	- Illustrate the concept of File systems and perform forensic analysis of file system. - Understand the storage fundamentals. - Explore the concept of evidence handling. - Grasp the knowledge of Intrusion detection and different attacks in network. - Analyse the attacks in networks.	- File Systems: FAT, NTFS - Forensic Analysis of File Systems – Storage, Fundamentals: Storage Layer, Hard Drives Evidence Handling: Types of Evidence, Challenges in evidence handling, Overview of evidence handling procedure. - Intrusion detection; Different Attacks in network, analysis Collecting Network Based Evidence - Investigating Routers - Network Protocols - Email Tracing- Internet Fraud.	
Module 4	System Investigation and Law		1
	LOs: Learners will be able to	**Module Contents:**	
	- Explore the data analysis techniques for windows and Unix. - Grasp the knowledge of different Hacker tools and ethical issues for cybercrime. - Enhance the knowledge of bodies of law related to digital forensic. - Illustrate the different levels of law and differentiate it. - Understand the laws related to computers.	- Data Analysis Techniques - Investigating Live Systems (Windows & 08 Unix) Investigating - Hacker Tools - Ethical Issues – Cybercrime. **Bodies of law:** Constitutional law, Criminal law, Civil law, Administrative regulations, Levels of law: Local laws, State laws, Federal laws, International laws , Levels of culpability: Intent, Knowledge, Recklessness, Negligence Level and burden of proof : Criminal versus civil cases ,Vicarious liability, Laws related to computers: CFAA, DMCA, CAN Spam, etc.	
Assignments/ Activities towards CCE			
	- Explore the history and evolution of Digital Forensic. - Provide information about different cybercrimes and differentiate between them. - Illustrate different file system concept and their structure. - Demonstrate and explore different attacks in network. - Explore different data analysis techniques for digital forensic using real or given scenario. - Represent demonstration of different hacking tool in real-time. - Synthesized the different digital forensic laws.		

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SN	Courses, Modules and Outcomes	Course Contents	Cr
	Semester IV		
425513	**Agile Methodology** **Major(Elective) Theory**		**4**
	Course Outcomes: **Learners will be able to:** • Apply the Agile requirement techniques for Software Development. • Analyze different Agile software methodologies to facilitate the Project. • Analyze different Agile Estimation Techniques. • Illustrate Agile Testing approach.		
Module 1	**Introduction to Agile Methodologies**		1
	LOs: Learners will be able to • Explain the traditional approach to software development methodology. • Identify the limitations and challenges of traditional software development. • Define the concept of Agile in the context of software development. • Introduce the Class Responsibility Collaborator (CRC) method for collaborative requirements analysis.	**Module Contents:** • Traditional approach of Software Development Methodology, Need of Agile software Development, Defining Agile,Agile Manifesto Principles of Agile , Values of Agile ,Business Benefits of Agile Software Development • Traditional Requirements Development , Principle of Agile Requirements Development ,Agile Requirements : Epics and User stories ,Difference between Epics and User stories ,Backlog Management, Class Responsibility Collaborator.	
Module 2	**Scrum and Kanban Methodologies**		1
	LOs:Learners will be able to • Define the Scrum framework and its role in Agile software development. • Identify and analyze the advantages and benefits of adopting the Scrum framework. • Understand the underlying principles that guide the Scrum framework. • Define and differentiate between key artifacts in Scrum, including the Product Backlog, Sprint Backlog, and Increments. • Define the Kanban framework and its principles. • Understand the concept of workflow in Kanban. • Explain the importance of limiting work	**Module Contents:** • Introduction to Scrum framework,Advantages of Scrum Framework.Phases of Scrum, Principles of Scrum,Roles: Product owner, team members and scrum master, Scrum Ceremonies :Sprint, sprint planning, daily scrum, sprint review, and sprint retrospective, Artifacts: Product backlog, sprint backlog and increments. • Introduction to Kanban framework, Workflow, Limit the amount of work in progress, pulling work from column to column, Kanban board, Adding policies to the	

		in progress in Kanban. • Understand the concept of work item age in Kanban.	board, Cards and their optimization.Kanban Practices , Kanban Flow practices.Work Item Age.Kanban vs Scrum.	
Module 3	**Extreme Programming and Agile Estimation Techniques**			1
	LOs: Learners will be able to	**Module Contents:**		
	• Gain a foundational understanding of the basic values and principles that underpin Extreme Programming (XP). • Learn and apply the twelve practices of Extreme Programming (XP), including pair programming, continuous integration, and test-driven development (TDD). • Explore the life cycle of an XP project, from planning to release. • Gain an understanding of the Agile Maturity Model and its levels, ranging from initial to optimized. • Learn and apply Agile estimation techniques, including Planning Poker, Shirt Sizes, Dot Voting, and the Bucket System. • Explore ways to optimize planning processes using Agile estimation techniques.	• Basic values and principles, Roles, Twelve practices of XP, Pair programming, XP team, Life cycle and tools for XP.,Good practices need to be practiced in extreme programming,Advantages of Extreme Programming • Agile Maturity Model and Agile Estimation Techniques - Planning Poker-Shirt Sizes. Dot Voting, Bucket System.		
Module 4	**Agile Testing**			1
	LOs: Learners will be able to	**Module Contents:**		
	• Understand the Agile Testing Quadrants model and its classification of testing activities into four quadrants. • Gain a comprehensive understanding of the Agile Testing Life Cycle and its iterative nature within Agile development. • Learn the principles and practices of Behavior Driven Development (BDD) as an Agile testing technique. • Gain an understanding of Agile test metrics and their role in measuring and improving the testing process. • Learn how to effectively use metrics to assess project progress and identify areas for improvement. • Identify common pitfalls associated with Agile test metrics and learn strategies to avoid them.	• Agile Testing Life Cycle, Agile Testing Quadrants, Agile Testing Techniques: Behavior Driven Development, Test Driven Development Acceptance Test Driven Development Testing.Role of Agile Tester.User stories approach in Acceptance Test Driven Development Testing.Other Techniques - Exploratory Testing , Session Based testing. • Agile Test Metrics.		

Assignments/ Activities	
These assignments aim to apply theoretical concepts to practical application and critical thinking. • Prepare a Product Backlog ,Epics and User Stories for a given scenario. • Write a Class Responsibility Collaborator for a given scenario. • Importance of Scrum Ceremonies in Scrum Framework. • Importance of Scrum Team Roles and Responsibilities. • Problems on Work Item Age. • Depict Kanban workflow. • Use various Agile Estimation Techniques. • Case study on AMM • Prepare Agile Test cases using Behavior Driven Development. • Prepare Agile Test cases using Acceptance Test Driven Development.	

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SN	Courses, Modules and Outcomes	Course Contents	Cr
	Semester IV		
425514	**Cloud Computing** **Major(Elective) Theory**		**4**
	Course Outcomes: **Learners will be able to:** • After completion of course, students would be able to: • Identify security aspects of each cloud model • Develop a risk-management strategy for moving to the Cloud • Implement a public cloud instance using a public cloud service provider • Apply trust-based security model to different layer		
Module 1	**Introduction to Cloud Computing:**		1
	LOs: Learners will be able to • Define and explain the concept of cloud computing. Identify the key characteristics, service models (IaaS, PaaS, SaaS), and deployment models (public, private, hybrid) of cloud computing. • Provide an overview of the historical development of cloud computing. Explain the evolution from traditional computing models to cloud computing. • Compare and contrast major cloud service providers such as Amazon Web Services (AWS), Microsoft Azure, and Google Cloud Platform (GCP). • Identify and analyze potential security risks and challenges associated with cloud computing.	**Module Contents:** • Introduction to Cloud Computing • Online Social Networks and Applications • Cloud introduction and overview • Different clouds, Risks, Novel applications of cloud computing	
Module 2	**Cloud Computing Architecture, Cloud Deployment Models**		1
	LOs: Learners will be able to: • Define the requirements that led to the emergence of cloud computing. • Provide an overview of the basic principles and concepts underlying cloud computing. • Explain CPU virtualization and its role in cloud architectures. • Discuss different hypervisors and their features. • Define and explain the SPI (Software as a Service, Platform as a Service, Infrastructure as a Service) framework. • Identify the key drivers motivating organizations to adopt cloud computing. • Evaluate the impact of cloud	**Module Contents:** • **Cloud Computing Architecture:** Requirements, Introduction Cloud computing architecture, On Demand Computing Virtualization at the infrastructure level, Security in Cloud computing environments, CPU Virtualization, A discussion on Hypervisors Storage Virtualization Cloud Computing Defined, The SPI Framework for Cloud Computing, The Traditional Software Model, The Cloud Services Delivery Model • **Cloud Deployment Models:**	

		computing on end-users and businesses. • Explore best practices for establishing effective governance structures in cloud environments	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	
Module 3	**Security Issues in Cloud Computing and Access management**			1
	LOs: Learners will be able to • Understand the importance of infrastructure security in cloud computing and identify key components involved. • Explain network-level security measures and protocols relevant to cloud environments. • describe application-level security practices and challenges specific to cloud-based applications. • Understand the significance of data security and storage in cloud computing environments. • Assess the security considerations related to data managed by cloud service providers. • Define trust boundaries and explain their significance in Identity and Access Management • Familiarize with key standards and protocols used for Identity and Access Management in cloud services. • Understand the concept of authorization management in the cloud and its role in ensuring secure access.	**Module Contents:** • **Security Issues in Cloud Computing**: Infrastructure Security, Infrastructure Security: The Network Level, The Host Level, The Application Level, Data Security and Storage, Aspects of Data Security, Data Security Mitigation Provider Data and Its Security. • **Identity and Access Management:** Trust Boundaries and IAM, IAM Challenges, Relevant IAM Standards and Protocols for Cloud Services, IAM Practices in the Cloud, Cloud Authorization Management.	
Module 4	**Security Management in the Cloud, Privacy Issues**			1
	LOs: Learners will be able to • Understand and apply security management standards relevant to cloud computing. • Differentiate availability management practices for Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS). • Conduct risk assessments specific to cloud security and propose effective mitigation strategies. • Develop and implement incident response plans tailored to cloud computing scenarios.	**Module Contents:** • **Security Management in the Cloud:** Security Management Standards, Security Management in the Cloud, Availability Management: SaaS, PaaS, IaaS. • **Privacy Issues:** Privacy Issues, Data Life Cycle, Key Privacy Concerns in the Cloud, Protecting Privacy, Changes to Privacy Risk Management and Compliance in Relation to	

	• Analyse the data life cycle and identify key points for addressing privacy concerns in each phase. • Identify and prioritize key privacy concerns that arise in cloud computing environments. • Propose and evaluate measures for protecting privacy in the cloud, including encryption and access controls. • Understand the legal and regulatory landscape related to privacy in cloud computing. • Summarize and interpret relevant U.S. laws and regulations pertaining to privacy in cloud computing.	Cloud Computing, Legal and Regulatory Implications, U.S. Laws and Regulations, International Laws and Regulations.	
Assignments/ Activities		
	These assignments aim to apply theoretical concepts to practical application and critical thinking. • Research and compare three major cloud service providers (e.g., AWS, Azure, Google Cloud) based on their service offerings, pricing models, and customer reviews. • Design a hypothetical cloud infrastructure for a given business scenario. Consider factors such as scalability, security, and cost-effectiveness. • Conduct a security risk assessment for a given cloud-based application. Identify potential vulnerabilities and propose mitigation strategies. • Develop a comprehensive security policy for a fictional organization migrating to the cloud. Address key security management standards and practices.	

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