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

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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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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.		

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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,chmod,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:IntroductionSection,ReadingUserInput,Arithmetic,PositionalParametersandCommandLineArguments, ConditionalConstructsandFlowControlSection,LoopingCommands,FunctionsSection,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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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	

	• 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.	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.	
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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<table>
<tr><th>SN</th><th>Courses, Modules and Outcomes</th><th>Course Contents</th><th>Cr</th></tr>
<tr><td></td><td colspan="2">Semester I</td><td></td></tr>
<tr><td>135511</td><td colspan="2">Research Methodology
Major (Core) Theory</td><td>4</td></tr>
<tr><td></td><td colspan="2">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.</td><td></td></tr>
<tr><td>Module 1</td><td colspan="2">Introduction to Research methodology</td><td>1</td></tr>
<tr><td></td><td>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.</td><td>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.</td><td></td></tr>
</table>

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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