

Elective 4

DISTRIBUTED LEDGER TECHNOLOGIES AND APPLICATIONS

Subject Code: CS35324CS	Subject Type: DE (Elective-4)	Evaluation Scheme: MSE (30), TA (20), ESE (50)	L-T-P: 3-0-0 (3)
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Pre-Requisites: NIL

Course Objective: To provide an understanding of Distributed Ledger Technology, blockchain architecture, and consensus mechanisms, and to develop skills for designing smart contracts and decentralized applications while exploring real-world applications and emerging trends.

Course Outcomes: At the end of the course, the student will be able to

CO	Course Outcomes
CO-1	Analyze the principles of Distributed Ledger Technology, cryptographic mechanisms, and blockchain architecture.
CO-2	Evaluate different consensus algorithms and security mechanisms used in blockchain systems.
CO-3	Design and implement smart contracts and decentralized applications using platforms like Ethereum and Hyperledger.
CO-4	Assess real-world applications of blockchain technology and propose suitable solutions for domain-specific problems.

Syllabus:

Unit-1: Foundations of Distributed Ledger Technology

Distributed Systems Fundamentals: Client-server vs Peer-to-Peer systems, Distributed trust and fault tolerance, Introduction to DLT: Centralized vs Distributed vs Decentralized systems, Blockchain as a DLT, Cryptographic Foundations: Hash functions (SHA-256), Digital signatures and public-key cryptography, Merkle Trees, Bitcoin Architecture: Transactions and UTXO model, Block structure and chain formation, Limitations of traditional systems and need for DLT.

Unit-2: Blockchain Architecture and Consensus Mechanisms

Blockchain Architecture: Blocks, nodes, ledgers, Full nodes vs light nodes, Consensus Algorithms: Proof of Work (PoW), Proof of Stake (PoS), Delegated PoS (DpoS), Byzantine Fault Tolerance (PBFT), Mining and Incentive Mechanisms, Forks and Consensus Failures, Security Issues: Double spending, 51% attack, Sybil attack, Permissioned vs Permissionless Blockchain.

Unit-3: Applications, Case Studies and Emerging Trends

Financial Applications: Bitcoin, Ethereum, Decentralized Finance (DeFi), Enterprise Applications: Supply chain management, Healthcare systems, Identity management (Digital ID), Advanced Topics: NFTs (Non-Fungible Tokens), Web3 and decentralized internet, Blockchain interoperability, Integration: Blockchain with IoT and AI, Legal, ethical, and regulatory challenges, Scalability and future directions.

Unit-4: Smart Contracts and Blockchain Platforms

Smart Contracts: Definition, lifecycle, execution model, Ethereum Platform: Accounts, transactions, gas, Ethereum Virtual Machine (EVM), Solidity Programming (basics): Variables, functions, events, Hyperledger Fabric: Permissioned blockchain, Channels and chaincode, Decentralized Applications (Dapps), Tokenization: Cryptocurrencies, ERC standards (ERC-20, ERC-721).

Learning Resources:

Text Books:

1. D. Hellwig, G. Karlic, and A. Huchzermeier, Build Your Own Blockchain: A Practical Guide to Distributed Ledger Technology. Springer, 2020.
2. S. Tanwar, Blockchain Technology: From Theory to Practice. Springer, 2022.

Reference Books:

1. I. Bashir, Mastering Blockchain, 4th ed. Packt Publishing, 2023.
2. R. Pandey, S. Goundar, and S. Fatima, Distributed Computing to Blockchain: Architecture, Technology, and Applications. Academic Press (Elsevier), 2023.
3. P. M. Jeyanthi, Ed., Distributed Ledger Technology in Communication: Integration of IoT, Blockchain and Metadata. Springer, 2026.