

BLOCKCHAIN TECHNOLOGY

Subject Code: CS34122CS	Subject Type: Elective
Evaluation Scheme: MSE(30), TA(20), ESE(50)	L-T-P: 3-0-0

Pre-Requisites: Computer Networks, Cryptography, Operating Systems, Programming (Python/JavaScript/C++), Basic Distributed Systems

Course Objective: To enable students to understand and build blockchain-based systems and applications. The course introduces distributed ledger technologies, cryptographic foundations, consensus mechanisms, and smart contracts, along with real-world applications and security considerations under legal and ethical frameworks.

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

CO-1	Understand the fundamental concepts of blockchain, distributed ledgers, and decentralization along with their architectural components.
CO-2	Analyze cryptographic techniques, consensus mechanisms, and protocols used in blockchain systems.
CO-3	Understand and implement blockchain platforms and smart contracts for decentralized applications.
CO-4	Evaluate blockchain security, privacy issues, attacks, and countermeasures in practical systems.
CO-5	Design and apply blockchain solutions in real-world domains such as finance, IoT, cloud computing, and digital governance.

Course Articulation Matrix:

CO/PO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6
CO-1	3	2	2	2	3	2
CO-2	3	3	3	3	3	2
CO-3	3	3	3	2	3	1
CO-4	3	2	2	1	2	2
CO-5	3	3	2	1	3	2

1 – Slightly; 2 – Moderately; 3 – Substantially

Syllabus:

Unit-1 Introduction to Blockchain and Distributed Systems: Overview of Blockchain Technology, Need for Distributed Record Keeping, Centralized vs Decentralized Systems, Distributed Ledger Technology, Peer-to-Peer Networks, Blockchain Architecture and Components, Block Structure, Transactions and Merkle Trees, Cryptographic Foundations including Hash Functions and Digital Signatures, Public Key Cryptography, Blockchain

Generations (Blockchain 1.0, 2.0, 3.0), Overview of Cryptocurrencies, Limitations of Traditional Systems and Motivation for Blockchain.

Unit-2 Consensus Mechanisms and Cryptographic Foundations: Distributed Consensus Concepts, Byzantine Generals Problem, Byzantine Fault Tolerance, Classical Consensus Protocols, Proof of Work (PoW), Proof of Stake (PoS), Delegated PoS and Alternative Consensus Mechanisms, Mining Process and Incentives, Cryptographic Primitives including Collision-resistant Hash Functions, Nonce, Hash Pointers, Merkle Trees, Digital Signatures, Public/Private Key Systems, Zero Knowledge Proofs, Security and Privacy Challenges in Blockchain.

Unit-3 Blockchain Platforms and Smart Contracts: Blockchain 1.0 – Bitcoin: Bitcoin Architecture, Transactions, Wallets, Mining, Nakamoto Consensus, Bitcoin Scripts, Network Structure, Attacks such as Double Spending and Selfish Mining, Blockchain 2.0 – Ethereum: Ethereum Architecture, Accounts, Transactions, Smart Contracts, Solidity Basics, Ethereum Virtual Machine (EVM), Proof of Stake, Blockchain 3.0 – Hyperledger Fabric: Permissioned Blockchain, Modular Architecture, Membership Services, Chaincode, Consensus Mechanisms such as Raft, Comparison of Public vs Private Blockchains.

Unit-4 Blockchain Security, Applications and Emerging Trends: Security Issues in Blockchain, Attacks and Countermeasures, Privacy in Blockchain (Pseudo-anonymity vs Anonymity), Zcash and Zero-Knowledge Proofs, Scalability Challenges and Solutions such as Sharding and Layer-2 Techniques, Applications of Blockchain in Finance (DeFi), IoT Security, Cloud Computing, Supply Chain, Digital Identity, E-Governance, Blockchain in Cyber Security, Smart Contract Vulnerabilities, Legal and Ethical Issues, Emerging Trends including Web3, DAOs, AI Integration with Blockchain, and Future Research Directions.

Learning Resources

1. Bitcoin and Cryptocurrency Technologies, Princeton University Press.
2. Mastering Blockchain, 3rd Edition, Packt Publishing, 2020.
3. Introduction to Cryptocurrencies, an online course by Haseeb Qureshi.

Reference Books

1. Blockchain Democracy, Cambridge University Press, 2020.
2. Blockchain Technology and Applications, CRC Press, 2021.
3. Blockchain Technology, Universities Press, 2020.