Module - 1 : Introduction to Blockchain

1.1 What is a blockchain, Origin of the blockchain (cryptographically secure hash functions), Foundation of blockchain: Merkle trees

1.2 Components of blockchain, Block in blockchain, Types: Public, Private, and Consortium, Consensus Protocol, Limitations and Challenges of Blockchain

1. Define blockchain and explain it with a suitable example.. Explain working steps of blockchain. What are the benefits of Blockchain technology? Explain in detail.
2. What are the Limitations and Challenges of Blockchain? What are the potential solutions for the scalability problem of blockchain? Differentiate between blockchain and bitcoin.
3. Write a short note on investing and trading. What are the different regulations around cryptocurrencies? How does lack of governance and standards affect the blockchain ?
4. Explain various components of blockchain Explain with a suitable diagram, the simplified architecture of a blockchain. What are blockchain events ?
5. Explain the blockchain ecosystem in detail. List and explain various actors in a blockchain solution. What is full node and partial node in blockchain?
6. Explain Generations of blockchain. Explain the historical perspective of blockchain.
7. What problems are associated with a centralized system? How does a blockchain transaction differ from a traditional transaction? Explain with examples.
8. What is a peer to peer distributed network? Differentiate between centralized, decentralized, and distributed architecture. What is a distributed ledger ? State several benefits of distributed ledger technology.
9. How public key cryptography plays a role in the security of blockchain? Explain with examples. What is hash and how it provides security in blockchain? Explain.
10. What are Merkle trees ? Explain the structure of a Merkle tree. What are the advantages of the Merkle tree? How does the Merkle tree ensure security in blockchain? Explain in detail with examples.
11. Explain Byzantine Generals Problem.
12. **What is a block in a blockchain? What are the various components that are present inside a block that help in forming a blockchain. With a suitable diagram, explain the structure of a block header with a list of transactions.**
13. **Explain different types of blockchain. Differentiate between public, private and consortium blockchain**.

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14. What is a public blockchain? Enlist a few examples of a public blockchain and state its advantages and disadvantages. State some characteristics of public blockchain.
15. What is a consensus protocol? State the properties of a distributed consensus protocol. What are the objectives of consensus protocols or mechanisms? Explain.

Module - 2 : Cryptocurrency

2.1 Cryptocurrency: Bitcoin, Altcoin, and Tokens (Utility and Security), Cryptocurrency wallets: Hot and cold wallets, Cryptocurrency usage, Transactions in Blockchain, UTXO, and double spending problem

2.2 Bitcoin Blockchain, Consensus in Bitcoin, Proof of Work (PoW), Proof of Burn(PoB), Proof of Stake (PoS), Proof of Elapsed Time (PoET), Life of a Miner, Mining Difficulty, Mining Pools and its methods

1. What is cryptocurrency? What are the different characteristics of cryptocurrencies? Explain different types of cryptocurrency.
2. What are the different players in the cryptocurrency ecosystem? Explain different cryptocurrency safety measures. Write a short note on : Cryptocurrency usage in India and in the World
3. Explain in short bitcoin blockchain. Explain bitcoin as cryptocurrency. What is the halving policy in bitcoin blockchain?
4. Elaborate on the concept of "Consensus in Bitcoin". Explain Block Propagation and Relay in bitcoin blockchain. Explain Proof of Work (POW) and Hashcash in Bitcoin.
5. Explain the concept of double spending with a suitable example? PoW solves the problem of double spending ?
6. What is forking? Explain different types of forks in Bitcoin & Ethereum Platforms
7. What is a wallet in blockchain? What are cryptocurrency wallets? What are the different types of cryptocurrency wallets? Explain. Differentiate between Hot wallets and cold wallets.
8. What are Altcoins? Write a short note on Ethereum , Ripple, Bitcoin Cash, Litecoin, EOS , Monero, Stellar.
9. What is a token? Explain different types of tokens. Explain utility tokens and security tokens in detail.
10. Differentiate between Altcoins, utility tokens and security tokens.
11. What is crypto mining? Explain. What are the different types of crypto mining? What is solo and pool mining?
12. What is a mining pool? Explain different types of mining pools. Explain software mining & hardware mining in bitcoin blockchain.
13. What is nonce? What is mining? Explain different steps involved in mining.

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14. What is meant by mining difficulty? How is the difficulty level of a block computed? How difficulty level is related to the hash rate. Explain the procedure of mining bitcoins by a miner. Write notes on the life of a miner.
15. What is Airdrop Cryptocurrency? Explain its advantages and disadvantages. Explain different types of airdrops.
16. What is token or coin burning? Why is coin burning necessary? What are the reasons behind burning the coins?
17. **Explain Blockchain transaction life cycle. Explain transactions in blockchain. What is a mempool? How miners pick transactions from the mempool**.
18. Explain the structure of the transaction in short. What is the transaction fee? Write short notes on UTXO. Explain how it prevents double spending
19. Explain the working of Proof-of-Burn (PoB), Proof-of-Stake (Pos), Proof-of-Elapsed Time (POET) algorithms. Enlist their advantages and Disadvantages.
20. Explain the working of Proof-of-work (PoW), delegated proof of stake (DPoS) , Proof of Authority (PoA) algorithm. Enlist their advantages and Disadvantages.
21. Explain the working of Practical Byzantine Fault Tolerance (pBFT) , Proof of capacity, RAFT. Enlist their advantages and Disadvantages.
22. What is proof-of-work you mean by (PoW)? How can cryptographic hash act as a good indicator for PoW ? What is Hashcash PoW ? Explain with an example.
23. Explain Sybil attack and denial of service (DoS) attack.
24. **Differentiate between PoW, PoS, and PoB, PoET**

Module - 3 : Programming for Blockchain

3.1 Introduction to Smart Contracts, Types of Smart Contracts, Structure of a Smart Contract, Smart Contract Approaches, Limitations of Smart Contracts

3.2 Introduction to Programming: Solidity Programming – Basics, functions, Visibility and Activity Qualifiers, Address and Address Payable, Bytes and Enums, Arrays-Fixed and Dynamic Arrays, Special Arrays-Bytes and strings, Struct, Mapping, Inheritance, Error handling

3.3 Case Study – Voting Contract App, Preparing for smart contract development

1. **Define the smart contract. What are the benefits of smart contracts? Explain various characteristics of smart contracts. Explain basic structure of smart contract.**
2. Explain working of smart contracts with examples. Explain different types of smart contracts.
3. Write a short note on Smart Contracting Devices (SCD).
4. What is an oracle? Explain its types. . Explain limitations of smart contracts.
5. Write a short note on decentralized applications (DApps)
6. Write a short note on Decentralized Autonomous Organizations (DAO).
7. Explain in short various data types, types of variables, various global variables, scope of the local and state variables, various operators. Explain each with an example.
8. Explain in short string data type, types of arrays, Enums and Struct data type, mappings and how it is created in Solidity. Explain each with an example.
9. **Explain in short different function visibility and qualifiers; Address and Address Payable, constructor. Explain each with an example.**
10. Explain in short an Abstract contract; how inheritance is supported; Error handling. Explain each with an example.
11. Explain various steps to develop a voting contract application.
12. What are the benefits and limitations of blockchain based electronic voting applications?
13. Explain various steps to develop an Ethereum smart contract.
14. How crowdfunding platforms can be managed using smart contracts.
15. State and explain some use cases of smart contracts in industry.

Module - 4 : Public Blockchain

4.1 Introduction to Public Blockchain, Ethereum and its Components, Mining in Ethereum, Ethereum Virtual Machine (EVM), Transaction, Accounts, Architecture and Workflow, Comparison between Bitcoin and Ethereum

4.2 Types of test-networks used in Ethereum, Transferring Ethers using Metamask, Mist Wallet, Ethereum frameworks, Case study of Ganache for Ethereum blockchain, Exploring etherscan.io and ether block structure

1. What is a public blockchain ? State some characteristics of public blockchain.
2. Explain the relationship between different blockchain layers.
3. Explain in brief the history of Ethereum.
4. Describe the architecture of Ethereum.
5. What is an Ethereum virtual machine (EVM) ?
6. Compare Bitcoin and Ethereum.
7. Explain Ethereum and components of Ethereum.
8. What is mining in Ethereum? Explain mining process in detail,
9. Short note on Ethereum transactions.
10. Explain accounts in Ethereum and its types. Differentiate between EOA and Contract accounts.
11. Short note on test networks in Ethereum.
12. Explain how to transfer Ethers using Metamask Wallet and on Mist wallet.
13. Explain different Ethereum frameworks.
14. Explain any one application using Ganache.

Module - 5 : Private Blockchain

5.1 Installing Hyperledger Fabric, Hyperledger Fabric Network, Building Your First Network, Hyperledger Fabric Demo, Hyperledger Fabric Network Configuration, Certificate Authorities, Chaincode Development and Invocation, Deployment and testing of chaincode on development network, Hyperledger Fabric Transactions.

5.2 Introduction to Hyperledger, Tools and Frameworks, Hyperledger Fabric, Comparison between Hyperledger Fabric & Other Technologies.

1. What is a private blockchain with its characteristics? What is the need of a private blockchain?
2. Explain state machine replication? How is a smart contract represented as a state machine? Why state machine replication-based consensus is preferred over a permissioned/private blockchain ? What is distributed consensus? What are the applications of state machine replication in a distributed environment?
3. State the requirements of a consensus algorithm. Explain PAXOS and RAFT consensus algorithms.
4. Explain Byzantine Fault Tolerant algorithm. Explain PBFT algorithm. What is the need of Practical BFT? What is a backup in PBFT?
5. What are the issues in the current supply chain management system? Explain how blockchain with Hyperledger fabric can help to overcome these issues.
6. Elaborate on the design limitations in a permissioned environment
7. What do you mean by crash or network/partitioned faults ? Why is there a need to have 3f+ 1 replicas to ensure safety in an asynchronous system when there are faulty nodes?
8. What is the difference between pre-prepare phase, prepare phase, and commit phase in PBFT.
9. What is a consortium blockchain ?
10. What is a Hyperledger ? What are its properties? Explain Greenhouse Structure of Hyperledger.
11. Short note on Hyperledger frameworks and Hyperledger tools (Sawtooth, Iroha, Burrow, Indy) . What are the different types of tools and utility libraries used by hyperledger ?
12. Differentiate between Hyperledger fabric and other technologies. Explain Hyperledger fabric with advantages. Explain Hyperledger Fabric V1 architecture.
13. Explain working of Hyperledger fabric. How to create a Hyperledger network.
14. State various use cases where Hyperledger is used.

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Module - 6 : Tools and Applications of Blockchain

Financial Services, Insurance, Government, Supply Chain Management, Healthcare, Healthcare payments pre-authorization, The Internet of Things (IoT)

1. How can blockchain help in providing secure and verifiable digital identities for citizens, and what are the implications for government services?
2. How can blockchain improve interoperability and secure sharing of electronic health records (EHRs) among healthcare providers?
3. Discuss the potential advantages and concerns of using blockchain for tracking pharmaceutical supply chains and preventing counterfeit drugs.
4. How can blockchain-based IoT networks improve device management, data monetization, and user privacy in the rapidly growing IoT ecosystem?
5. Discuss the potential impact of blockchain on reducing fraudulent activities in the insurance sector. Explain how decentralized identity management using blockchain can enhance customer data privacy and trust in insurance transactions.
6. In what ways can blockchain technology enhance transparency, security, and efficiency in government services and record-keeping? Discuss the challenges and benefits of implementing blockchain-based voting systems for elections.
7. How can blockchain improve the claims processing and verification process in the insurance industry? Provide practical use cases.
8. What are the potential challenges and benefits of implementing blockchain-based cross-border payments systems? Discuss the role of smart contracts in automating and streamlining complex financial processes. Provide real-world examples.
9. Explain how blockchain can address issues of traceability and authenticity in global supply chains. Discuss the potential role of smart contracts in automating supply chain agreements and reducing disputes between parties. What challenges might arise when implementing blockchain in complex multi-party supply chain networks, and how can they be mitigated?
10. Explain the concept of patient-controlled health data access through blockchain. What are the implications for patient privacy and data security? Describe how blockchain can streamline the process of healthcare payments pre-authorization, improving accuracy and reducing delays.
11. Discuss the role of smart contracts in automating the validation and authorization of medical procedures for insurance claims. What challenges might arise in integrating blockchain-based payment pre-authorization systems with existing healthcare IT infrastructure?
12. Explain the synergy between blockchain technology and the Internet of Things (IoT) in terms of data integrity, security, and decentralized data exchange. Discuss the potential challenges and solutions when implementing blockchain for secure and trustworthy IoT data sharing.

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